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QUARTERLY

OF THE

National Fire Protection Association

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National Fire Protection Association.

Executive Office, 87 Milk Street, Boston, Mass.

Members.

October, 1916.

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American Institute of Electrical Engineers.
American Institute of Mining Engineers.
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Underwriters' Laboratories.
Vancouver Island Fire Underwriters' Association.
Water Works Manufacturers Association.
Western Actuarial Bureau (Fire).
Western Canada Fire Underwriters' Association.
Western Factory Insurance Association.
Western Insurance Bureau.
Western Improved Risk Association
Western Sprinklered Risk Association.
West Virginia Inspection Bureau.
Wisconsin Inspection Bureau.
Wisconsin State Fire Prevention Association.

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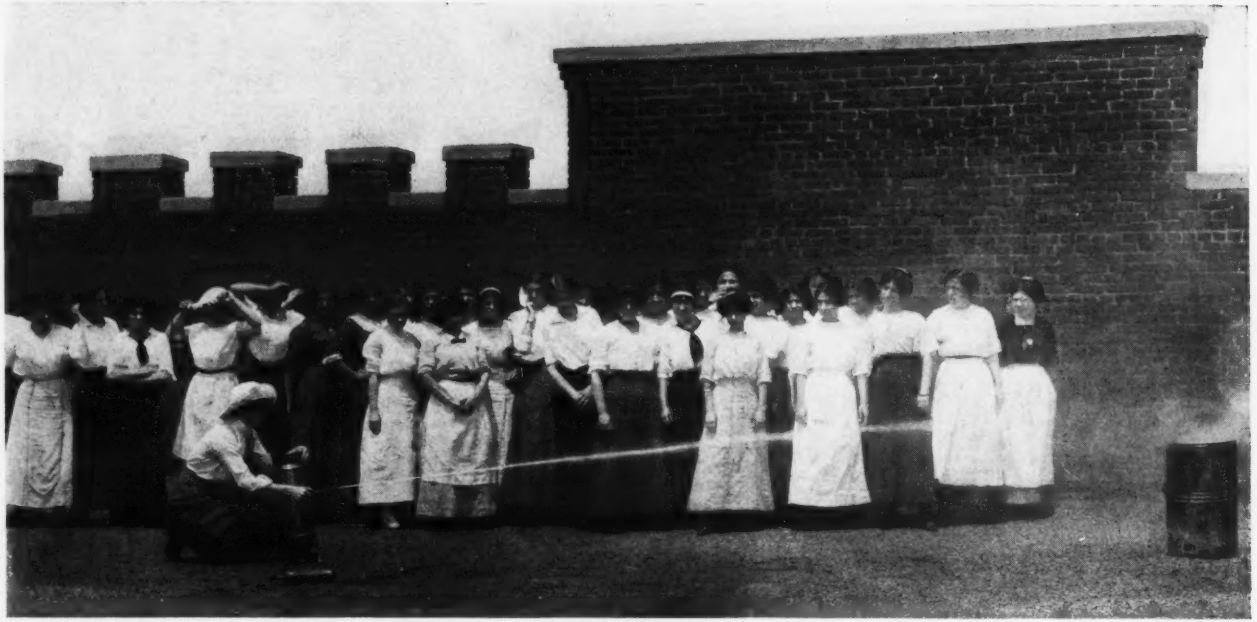
Reports on fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body is not responsible for the statements or opinions of any of its members.



Courtesy of *Factory*

THESE WOMEN KNOW BETTER THAN TO SCREAM AND RUN

Well-drilled and carefully instructed women may apply fire-fighting methods to a blaze in its early stages as well as men, but excellent extinguishers are valueless in the hands of untrained employees. A periodical drilling of all employees in the proper use of fire-fighting equipment is a worth-while proceeding in almost any plant.

The grammar school Principal went from room to room explaining what to do in case of fire. The pupils listened with respectful attention until he came to his final instructions, then smiles and giggles disturbed the Principal's serenity.

"Above all things," he said, "if your clothing catches fire, remain cool."

The Quarterly

Vol. 10. October, 1916 No. 2.

The Association's Summer Activities. The mid-summer, always a busy season in the executive office of the N. F. P. A., brought with its advent this year a number of new activities not the least of which was the joint campaign undertaken with the National Safety Council to promote *Fire and Accident Day* observance throughout the nation on October 9th. Notes on responses to this effort are given in another column. The cities in which we attempted to get results by direct correspondence with their civic or commercial organizations (all cities of 10,000 population or over) fell into two classes almost at the beginning; one class going ahead and working out its own program with the help of such suggestions as we had to offer; the other class expecting to have everything done for it even to being furnished literature for free distribution. The correspondence of both our co-operating national organizations was voluminous, and from it we have derived a knowledge of local facts, conditions and psychology, bound to be helpful next year and in all future years. The cities of the country must learn that all we can do is to stimulate local initiative and activity. Where there is no possibility of this there will naturally be no result.

The distribution of the *Year Book and Membership Directory* which usually reaches the members by August was delayed this year by the decision of the officers to assemble the names of associate members under the cities and towns in the several states and provinces in which they reside. It is believed this plan will be agreeable and helpful to members in enabling them easily to locate other members living in the same city. It also shows interestingly the distribution of the membership.

The *Monthly News Letter* which made its first appearance this month is an innovation very favorably received by the membership as calculated to promote the N. F. P. A. spirit and to bring members in touch with the activities of other members. Its regular monthly issue will entail an expenditure of from $800 to $1,000 per year not counting labor or overhead. Postage represents one-third of this expense. The number of pages of the *News Letter* will of course vary with the number of news items the secretary may have for each issue.

It was at President Meek's suggestion that the pamphlet, *Topics for*

Fire Prevention Meetings, was worked out by the secretary and distributed to the membership. It is believed it will be helpful in stimulating the production of local papers and addresses on the fire waste by indicating that the subject is a diversified one to which a number of speakers may contribute without duplication of matter. Our valued member the National Association of Credit Men is already industriously distributing this publication.

The pamphlet, *Outside Stairs as Fire Exits*, also mailed to members this month, makes accessible to the public for the first time the best word that can be said up to date on this subject. This is a valuable contribution of the *Committee on Safety to Life*, the portfolio of which is directed by Mr. H. W. Forster.

The pamphlet *Structural Defects* prepared by Mr. Benjamin Richards' *Committee on Manufacturing Risks and Special Hazards* is nearly ready and will be mailed shortly. The *Syllabus for Public Instruction in Fire Prevention* has been revised and will be re-issued. The National Board of Fire Underwriters is printing the revised pamphlet *Suggestions for Protection Against Lightning* and the Executive office hopes to publish before the end of the year a bulletin on the safeguarding of electric pressing irons.

* * * * *

Fire Restrictive Construction. An interesting example of the virtue of fire resistive construction in which there is no wooden trim in the matter of doors, door casings, etc., is afforded by a recent fire in the forty-two story building of the L. C. Smith Company in Seattle. A closet and pipe shaft in the stair corridor of the thirty-fifth floor was fitted at its opening with an approved metallic door and trim. The janitor after the manner of his kind had used this little opening as a depository for rags, a basin of elastic cement, a bottle of gasoline, broom, brushes and the carpenter's hammer, all used the previous day in stopping leaks in the observation floor. On opening the little metal door the following morning it transpired that everything combustible in this closet and its pipe shaft area had been consumed by fire even to the entire hammer handle. The partition or wall tile showed the effects of great heat. Being a pipe shaft the supply of oxygen probably fed the fire which, had it occurred in a tight closet, would have been smothered by lack of oxygen, consuming only the more inflammable materials. The bucks behind the metal jamb were badly burned in places but there was hardly a sign even of discoloration on the hall side of the closet, apparently no fire whatever issuing around the hollow metal trim or closet door edges. Fire Marshal Bringhurst said, "We are extremely glad the fire broke out where it was surrounded by incombustible material, for a thirty-fifth floor is an awkward place to fight fire." This fire recalls one reported in the Singer Building, New York, some years ago which was not so much noted for the damage it did as for what might have happened if the building had not been equipped with metal doors and trim.

What Forest Fires Cost Canada. Canada has lost through forest fires in 1916 over nine million dollars, according to information supplied to *Canadian Finance* by Robson Black, secretary of the Canadian Forestry Association. This equals more than six times what has been spent on forest protection work from coast to coast. The enormous sum wasted through this year's forest fires, most of which were preventable, would add another $480 to the first year's pension allowances of nearly 19,000 Canadian soldiers.

In areas where first rate fire protection systems are in operation, losses of life and property have been held down to a remarkable minimum. Within the 24,000 square miles of Quebec covered by the two well-organized associations of limit holders, the amount of green timber burnt was practically negligible. This immunity was due to consistent effort to educate settlers, lumberjacks and others in care with fire, coupled with a system of promptly reporting all outbreaks, and attacking forest fires in their incipiency with large forces of men and modern equipment.

British Columbia faced fairly favorable fire conditions through the summer months and the cost of fire fighting was reduced by about seventy-five per cent. from the record of 1915. The number of fires was about half of last year's. The British Columbia forest protection service is the most complete in Canada thus far, and the saving of timber is a logical consequence.

A heavy average of rainfall kept fire troubles at arm's length in Alberta, Saskatchewan and Manitoba, and this weather condition was undoubtedly responsible for the escape of the main areas of big timber throughout Ontario. The Claybelt fires at the end of July and first week of August provided a tragic sacrifice of 262 lives and what is estimated to be six million dollars' worth of property. There was practically no forest guarding organization in the fire-swept district, except along the railway track.

New Brunswick escaped the risks of 1916 with a very small timber loss, Nova Scotia having a similar experience. The records of the Dominion Railway Board show that the private-owned railway lines of Canada have not been responsible this year for any damaging forest fires. Those that were started were promptly extinguished by railway employees.

* * * * *

Using the Metric System. One incidental result of the war is that large numbers of manufacturers and workmen in England and the United States have for the first time become familiar with the metric system thru its use in making goods for the continental Allies. Now, after a man has been using the metric system it is as hard for him to go back to our awkward and irrational weights and measures as it is for one who is accustomed to the decimal coinage of other countries to use pounds, shillings and pence. The theoretical superiority of the metric system has always been well known and conceded in Anglo-Saxon countries, but so long as the people were unacquainted with its practical advan-

tages thru personal employment of it, the movement for its general adoption made little progress. Now the general public is becoming familiar with it and the American or Englishman talks about "42-centimeter guns" and "203-meter hill" as easily as if he were a Frenchman or German.

The scientific and engineering societies of Great Britain are urging that the metric system be made compulsory, and the question has already been brought up in Parliament as a necessary means of trade expansion. A country that insists upon its customers using its own local weights and measures instead of those of the rest of the world will be at a permanent disadvantage. The Pan-American conferences always talk about the desirability of a common system in the Americas and always recommend the metric, but the United States holds out like an obstinate juror against the other twenty republics. Recently, however, it seems that American prejudice is dying down. Our member The National Wholesale Grocers' Association is awake to the need and has recommended that the metric equivalents of the weight of contents be printed upon all packages. Our schools have long included the metric system in their curriculum, but it has often been taught in a perfunctory and uninviting way. Now is the time for teachers to take it up in earnest and give their pupils a practical acquaintance with its advantages.

* * * * *

Ordinance Follows Black Tom Explosion. Railroads having terminals in Jersey City have been notified by director of public safety, Frank Hague, that a new ordinance to safeguard the city against the shipment of dangerous munitions and high explosives has gone into effect. The new regulation requires that cars carrying munitions or explosives shall be labeled to distinguish them from other freight cars, and that such freight shall be unloaded only in the daytime, shall be sidetracked on special tracks used for no other purpose, and shall be handled at once. The penalty for a violation of the ordinance is a fine of $250. Indictments following the investigations of the explosion are now before the new grand jury of Hudson county.

Fire and Accident Prevention Day, 1916.

October 9th, the anniversary of the great Chicago fire, has for some years been qualifying for national recognition as "Fire Prevention Day." Largely owing to the efforts of our member The Union's Committee on Publicity and Education, of which Mr. Thomas R. Weddell, Chairman of the N. F. P. A. Committee on State Fire Prevention Associations, is the enthusiastic secretary, observance of the day had already become general throughout the western states; but the present year marks the first attempt to secure nation-wide observance. The new departure has meant the covering of a wider range not only of territory but also of subject matter, for on this occasion the National Safety Council, which stands for accident prevention, has joined forces with the National Fire Protection Association, in the effort to arouse public interest in "*Fire and Accident Prevention Day.*" Needless to say, our work has been supported by the national associations of fire chiefs and fire marshals, to say nothing of a host of chambers of commerce and local organizations of various kinds. The National Association of Credit Men rendered yeoman service by circularizing its local associations and urging them to co-operate in any local celebrations.

The ambitions of the two associations were no more limited by political boundaries than is their membership, and preparations had been set afoot for simultaneous celebrations across the border in Canada, and everything seemed shaping well, when the Canadian Government issued a proclamation appointing October 9th Thanksgiving Day. This coincidence of course necessitated an abandonment of the Canadian plans, and disappointed for a year the hopes of those who had looked for a continent-wide rather than a nation-wide observance of Fire and Accident Prevention Day.

It will obviously be impossible, for a long time yet, to estimate the results that have been accomplished or to compare the effectiveness of various local methods. A study of the records of fire and accident losses a few months hence may possibly yield evidences of the good work done, but the full effects — particularly as regards fire prevention — will probably not be felt until the children whose minds are now being formed, come to have votes of their own enabling them to secure improved legislation, and homes of their own in which they can turn to account the lessons they have received upon the dangers incident to neglected furnaces, heaters and chimneys, untidy basements and the careless use of matches. Indeed, one of the most hopeful circumstances connected with the whole scheme is the unanimity with which attention has been directed to the school. Commissioner P. P. Claxton, of the Bureau of Education at

Washington, issued a special notice drawing attention to the desirability of observing the day in the schools, and his advice seems to have been very generally followed. In many places talks were given by uniformed firemen, with the accompaniment in some cases of demonstrations with chemical extinguishers. Fire drills were included in some school programs and prizes were offered for essays on Fire Prevention Topics. So far as information is to hand, emphasis was laid in the schools mainly on fire prevention, but an illustration of the effective way in which the treatment of fire and accident hazards can be combined is afforded by the pamphlet issued by Fire Marshal M. J. Cleary for use in the schools of Wisconsin on October 9th. In addition to a fund of information about fires, fire extinguishers and the hazards of the ordinary home, the pamphlet contains warnings against carelessness in relation to railway tracks, thin ice, deep water, swift streams, dangerous farm animals, farm machinery, and so forth, together with the National Fire Protection Association's "Fable for Builders," telling of the "good citizen" who built fire traps for a living. Scores of thousands of forms upon which to report the results of fire inspections of their homes were distributed among the high school students of Indiana and Louisiana. In Louisiana this work was done under the auspices of our member the State Society for the Reduction of Fire Waste; in Indiana by the State Fire Marshal.

The attractive poster prepared by the two national associations was widely distributed and in some cases the occasion was also advertised by special posters issued locally. Twenty thousand signs reading: — "This is Fire Prevention Day. Clean up Rubbish," were distributed in New York. In Philadelphia 3,000 city vehicles were decorated with oblong yellow posters over three feet long with this inscription: —

Stop Fires and Accidents **In your city, your home, your family** **Fire and Accident Prevention Day** **One Day for Humanity**	**OCTOBER** **9th.**

Insurance Commissioner James R. Young of North Carolina also put out two or three very effective posters offering suggestions and inviting the co-operation of citizens in reducing the state's fire waste. In the City of Cleveland, 750 copies of the national associations' poster were distributed by the local Association of Credit Men, and a striking folder setting out a dozen simple methods of reducing the fire waste was issued by the Chamber of Commerce. In Wisconsin the Industrial Commission prepared a useful poster dealing with both fire and accident hazards.

Pageantry was called in to serve the good cause in quite a number of cities. Several new features were introduced into the New York Fire Prevention Day Parade by Fire Commissioner Adamson. One float represented the annual fire waste in the form of a pile of gold; another illustrated the hazards of benzine, gasoline and naphtha, and a third

emphasized the importance and value of fire drills. Chicago reminded itself of 1871, and incidentally did educational work among the citizens of to-day, by burning a replica of Mrs. O'Leary's barn on the waterfront. Rochester, a city which under the able and tactful leadership of its Chamber of Commerce has already accomplished a great deal of good work in this direction, celebrated the occasion with a Safety and Fire Prevention Show at Convention Hall. Kansas City has also come to the fore this year, arranging its exercises along lines very similar to those which have proved successful in Rochester.

In hundreds of factories throughout the country, arrangements were made for talks to the employees on accident prevention, and in many cases fire prevention also received attention. Fire Prevention Commissioner O'Keefe, for example, issued a circular to all factories in the metropolitan district of Boston employing more than one hundred persons, requesting employers to make inspections of heating and blower systems, to hold fire drills and to give personal consideration to the equipment of their plant in the matter of fire escapes. The semi-privacy in which this sort of work was done prevents it from receiving its full meed of public recognition but in no way detracts from its public usefulness.

About fifty Chicago clubs and societies were asked to hang posters, and the hotels and restaurants were invited to print a line or two on their menu cards calling attention to the day and its objects. Chief McDonnell of the Chicago Bureau of Fire Prevention and Public Safety, issued a notice to six hundred theatres requesting them to display on their screens an announcement slide setting forth a few important precautions that should be taken by the good citizen. A special luncheon was held under the auspices of the City Club of Chicago, the Illinois State Fire Prevention Association, the Chicago Local Council No. 3 of the National Safety Council, and the Chicago Chapter of the National Fire Protection Association, at which addresses were delivered on fire and accident prevention. In some places the co-operation of the clergy was obtained on Sunday, October 8th, and reference was made in many pulpits to the ethical and religious aspects of these questions. Much was also done by sympathetic newspaper men to impress upon the public, through leading articles in the press, the significance and importance of the movement, and it is interesting to note that this form of service, being compatible with the observance of Thanksgiving Day, was shared by Canadian writers, the *Ottawa Citizen* of October 9th, for instance, devoting an editorial to the subject.

In pledging itself to assist in the observance of Fire and Accident Prevention Day, the Central Trades and Labor Council of Rochester recorded its appreciation of the "wonderful results" that had been achieved in the factories, homes and streets of Rochester by the educational efforts of previous years. Rochester has been one of the pioneer cities of the movement, but it is surely not too much to hope that what has been accomplished in a single city can be repeated on a larger scale by the united efforts of a whole people.

The Black Tom Island Disaster.

By W. T. Colyer (Member N. F. P. A.)

Preeminent in interest among the numerous fires and explosions that have resulted from the present abnormal traffic in munitions of war, stands the Black Tom Island disaster of July 30, 1916. The preeminence consists not alone in the pecuniary value of the property destroyed — though that is estimated at about $20,000,000 — nor in the loss of life and personal injury inflicted on the general public — though nearly sixty people are known to have been direct sufferers (including six killed) — but in its revelation of a condition of affairs under which innumerable human lives and vast quantities of property are menaced every day by the possibility of similar disasters at a variety of points where munitions are being handled in transportation or storage.

The endeavors of the National Board of Fire Underwriters to secure an investigation by the Interstate Commerce Commission into the facts and circumstances surrounding the fire and explosion have elicited the fact that cars loaded with millions of pounds of high explosives may be kept in railroad yards in close proximity to buildings occupied as human habitations, at the same time that the storage of much smaller quantities of explosives in properly constructed and approved magazines is governed by strict regulations prescribing the distances which must intervene between the explosives and various classes of buildings, highways and — grim irony — railroads. It has been held in the courts that municipal authorities lack power to regulate the transportation of explosives through cities, the Federal authorities possessing sole jurisdiction over interstate commerce. Instances are, in fact, on record of the disregard of precautions demanded by a local fire department. On the other hand, the Interstate Commerce Commission has taken the view that in the absence of evidence of violation of its regulations governing the packing and handling of explosives, it has no authority to undertake the desired investigation.

The story of the *results* of the explosions — the rain of shells upon the surrounding country, the destruction of huge warehouses and their contents, the damage to the immigration station on Ellis Island, the bespattering of the Statue of Liberty with shrapnel, the strewing of miles of streets with broken glass and shattered signs — has been told in the daily press. The story of the *causes* of the disaster has been a matter of controversy from the beginning and the real facts will probably not come to public knowledge until an official investigation is made by the Interstate Commerce Commission or until and if litigation ensues, but it seems clear

that, as a matter of fact, the fire started shortly after Saturday midnight among some freight cars on the pier several hundred feet distance from the warehouses. It would also appear that explosive laden barges were at or in close proximity to the piers. The first explosion occurred at about 2.08 a. m., but the fire appears not to have gained much headway until after the second explosion which occurred twenty-two minutes later, which seems to have widely scattered burning embers which, apparently, started fires in many places.

There seems to have been considerable delay in informing the Jersey City fire department of the outbreak of the fire. In the official statement issued by the department on the day of the disaster it was announced that the battalion chief in charge of the fire engines dispatched to the scene on the first call, found the fire already a large one, and that he experienced difficulty in getting his engines within striking distance. Moreover, water could not be obtained from the railroad standpipes. From another source it is learned that fire had been observed a considerable time prior to the summoning of the fire department, and the suggestion has been made that the fire had been in progress for more than an hour before the occurrence of the first serious explosion.

Thirteen newly sprinklered brick storage warehouses, owned and operated by the National Storage Company, and several piers leased by that company to the Lehigh Valley Railroad, were destroyed together with more than eighty loaded cars. The warehouses had an excellent private water supply, but the shock of the first explosion is thought to have put the system out of commission. At all events, the only supply available was from a one-pipe line from Jersey City, and this proved utterly inadequate even when aided by fire tugs from the harbor. The discovery of munition boxes drifting about the harbor, into which they had been hurled by the explosions, caused much anxiety among pilots of harbor craft. On the following day a serious outbreak occurred among the ruins caused by the first fire. On this occasion also there were numerous explosions of shells, and the fire chief of Jersey City was reported to have expressed the opinion that the ruins would continue to smoulder for a week. The fire actually burned for fully two weeks before it was quenched.

Notwithstanding the fact that the Storage Company and the Railroad have been censured by a coroner's jury for their neglect to take adequate precautions to safeguard the public in connection with their handling of explosives, the situation does not appear to have been remedied, and large numbers of cars loaded with high exploives continue to be received into the yards of Jersey City. Clearly, the thorough and impartial investigation which is desired by the National Board of Fire Underwriters, and the idea of which is approved by the Interstate Commerce Commission, is urgently needed not only to dispel the obscurity which still surrounds the origin of the Black Tom disaster, but to devise effectual means for the protection of the people against any repetition of the offence.

Property "Rights" and the Fire Waste.

By Robert D. Kohn (Past-President N. F. P. A.)

Many years ago a charming genial professor of Columbia University, a man much beloved by his students, announced to an entering freshman class these principles with regard to the government of his department of the University, "There are no rules or regulations in this department. I never see a rule or hear of a regulation that does not incline me offhand to contravene it; though I may not have even realized the purpose of the law, or know what it is all about. There is a natural opposition in every American against restraint when that restraint is specified in terms of law. So then the only thing that is imposed on my students is that they shall so act as to respect the rights and privileges of their fellow students and make possible the accomplishment of the ends for which they have come to this college." If I remember rightly, this kindly professor's very diplomatic announcement was effective. The professor had undoubtedly voiced a very natural impulse of Americans. We are perhaps, more than citizens of any other country, "agin the government" even though we and others like us *are* the government.

The attitude of the property interests of our country towards restrictive legislation with regard to the fire hazard in building construction and building maintenance is well known. It has been in general antagonistic towards legislation which was believed to impose unnecessary expense upon the owners of property. Yet if I judge the present situation correctly, a good deal of the opposition to legislation is due to a misunderstanding as to what is really the *best interest* of the property owner. Unquestionably some of the opposition is due to that same spirit which the professor had so clearly recognized. A study of the fundamental principle at stake is certainly worth while.

In the eastern part of our country we have very early records with regard to fire preventive legislation. "An act for the more effectual prevention of fires and for regulating of buildings in the City of New York," passed in 1761, provided that "every building that shall be erected after January 1, 1766, in the City south of 'Fresh Water' should be made of stone or brick and roofed with tile or slate." It provided moreover a penalty of 50*l.* for every violation and further provided that every building built or roofed contrary to the meaning of the act should be deemed to be a public nuisance! As early as October, 1691, an act was passed called "An Act for Regulating Buildings, Streets, Wharfs, Docks, etc., of the City

of New York," which gave to the Mayor and Aldermen authority to make such rules, though the act did not itself prescribe any rules. An early Colonial law prohibited the construction of "wooden chimneys lathed and plastered on the inside." That ordinance at any rate seems to have been effective. We need hardly worry about this particular form of construction to-day.

There was a long gap between this legislation of the eighteenth century and modern fire preventive legislation. It seems as if little progress was made until 1885 or 1886. The middle part of the nineteenth century was a period when most of the building legislation was confined to devising rules for the required strength of materials. It endeavored in the main to prevent the wreck of buildings through bad construction. Engineers and architects were apparently employed only in the most important cases, and hence rules had to be made to prevent the so-called builders from putting up dangerous structures. This was the period when fire resistant construction was only beginning to be developed, and was supposed to be entirely too expensive to warrant its use in any but the most important buildings of a more or less public character.

Then came the time when it was realized that all this should be changed. Not only was the congestion in the cities increasing, but even the suburban and farming districts were growing together, and large areas of combustible structures were thus exposed to conflagration hazard. What was still more serious was that buildings designed for residence or shop purposes were used as factories, frequently for the dangerous trades, and thus unlooked-for calamities were the result. Little by little the increasing complication of life and industry throughout the country had brought about these increased hazards. Everywhere the cry was heard for more drastic building regulation.

This justifiable reaction from the indifference of the previous period is a reaction which is still on the increase, but it produced and is likely to produce in the future a new danger. Each new accident, each great fire where lives are lost, causes a new demand for specific legislation; when the real need is for a study and a definition of the general ends to be attained. We are therefore in danger of inflicting upon our communities laws so specific that they absolutely prevent individual initiative and prevent the discovery of the new and desirable forms of construction. To-day we have reached a point where in our building legislation we should not attempt to secure manuals to guide the ignorant builder nor statements of how a building shall be erected, but rather should secure laws indicating the measure of safety to be provided in buildings no matter where erected. We must do this if we wish to avoid that natural opposition to restrictions in any form, reference to which has previously been made. We must leave to the individual the working out of the means by which these measures of safety shall be attained.

It is in the nature of the fire prevention legislation that has been proposed in the past that we may find the source of some of the opposition which the property interests have shown. In this respect the writer prob-

ably differs little from the average. If he reads in some proposed law that he must make the pins on the hinges of a fire exit door not less than ⅜ of an inch in diameter, he finds this very irksome, is inclined to want to make them ¼-inch or ½-inch; whereas he would not think of opposing a law which merely said that fire exit doors shall be securely hung and swing easily. The tendency throughout the country is unfortunately to further legislation which is too specific. We unquestionably need State building codes because the risk in the rural districts is as great in an industrial building as it is in a large city; because even rural residence districts rapidly grow into suburbs and then become part of the cities themselves, and thus eventually form dangerous fire hazards. But what we want particularly to insure in State building code legislation is that it shall be general in its terms. Some States have already adopted building codes. Parts of the Ohio State code for instance known to the writer are particularly noticeable for their painfully specific requirements.

Granted then that there has been some reasonable excuse for the opposition that property "rights" have shown to some proposed fire prevention legislation, it is none the less true that most of that opposition has been based on misunderstanding or ignorance. The principle of definite fire preventive legislation both for old and new buildings is right and wise. No opposition is justified unless it confines itself to criticisms of means by which the desired objects are to be attained. Criticisms of the objects themselves, the safety of life and property against the fire hazard would be in the highest degree unreasonable and reactionary. The reason for this is that it has become almost a commonplace to say (though apparently it has never penetrated the minds of the many property owners) that the fire hazard is a piece of uneconomic foolishness. The time is near when the gradually increasing cost of combustible construction with its high cost of upkeep, as against the constantly lowering price of incombustible materials, will make the old combustible construction almost an anachronism.

What stands in the way of reform in this whole matter of fire prevention is ignorance, and not an anti-social selfishness, as has so often been claimed. The ignorance and worse than that, the indifference, is not confined by any means to the property owners and their representatives, but it is common enough among the architects and the builders even in our large cities. There is no longer any excuse for it. The science of fire preventive construction has made wonderful strides in the last twenty years. The results of experience and tests have been made available, almost for the asking. Fire resistive construction and fire protective devices are no longer an experiment or merely an extravagance allowable to wealthy corporations. It is no exaggeration to say that there would be actual economy in cost for the owners in the substitution of fire resistant for combustible materials in at least one-third of all the building work now being erected of combustible material in this country. Millions of dollars, in other words, are being invested each year in buildings, both in cities and in the open country, which are not only dangerous to life and

liable to cause a great financial loss, but they are being erected in a way that is actually wasteful of the money of the person who is erecting them, either in original cost or in upkeep. In every part of the country we still see common "joist constructed" industrial buildings. Stores and shops are still being erected by the thousands in this way, after forty years of successful use of the so-called "mill construction" and twenty years of gradually reducing cost of steel and tile and concrete. Such continued use of a bad type is frequently little short of an economic crime. Even in that fairly large percentage of cases where the heavy timber or fire resistant construction cannot for some reason be used, the low cost of adequate and simple fire prevention means puts them within reach of almost all. In such cases, care in chimney construction, care with electric wiring, the isolation of heating and power apparatus, the separation of stories and large areas from each other, the enclosures of stairs, elevators and hatchways and the admirable sprinkler systems — these are things which should not need to be enforced by law; they should come from the common sense of the owner. We do then indeed need a protection of the "rights" of the property owner. It may be to a slight degree protection against complex and too specific legislation; but in the main we need protection against the results of our own blind ignorance as to our own best interests.

Some years ago there was an interesting illustration of our common attitude towards any suggested change or reform. It was the case of an owner who had for years paid sums of money to inspectors from different city and state departments to avoid compliance with an order requiring a certain change in his building. The sums of money thus paid had in the long run probably amounted to over a hundred dollars. The change when it was finally voluntarily made (without subsequent inconvenience of any kind in the use of the structure) cost exactly $33. This tale is not told to point a moral (the moral is probably bad!). It is recited merely as an indication of that same unthinking attitude which is responsible for most, if not all, of our inexcusable fire waste.

It is the most hopeful sign of the times that that attitude is changing.

MANHATTAN.

Clarke Fox Hunn.

They have heaped Woolworth upon Singer Tower
And bade you bear them.
The griping claws of their great caissons
Bite deep to the bone.
They have laced your flesh with sewers and subways.
And all, with one deft twisting of your long body,
You might confound.
Why do you lie there so complacent, O Manhattan?
Are you so dull of sense?
Or are you, perchance,
Lulled into slumber
By the soft tickling
Of our
Ten million little feet?

Community Rights in City Planning.

By Frederick L. Ackerman.

Journal American Institute of Architects.

I know of no more significant document relative to the subject of city-planning, and the function of government as thereto related, than the full-page advertisement in the New York papers of Sunday, March 5 last, entitled "Shall We Save New York? — A Vital Question to Everyone Who Has Pride in His Great City." This advertisement contained the following explanatory paragraph and "Notice to all interested."

"Shall we save New York, from what? Shall we save it from unnatural and unnecessary crowding, from depopulated sections, from being a city unbeautiful, from high rents, from excessive and illy-distributed taxation? We can save it from all of these, so far at least as they are caused by one specified industrial evil — the erection of factories in the residential and famous retail section.

"In view of the facts herein set forth, we wish to give publicity to the following notice: We, the undersigned, merchants and such others as may later join with us, will give the preference in our purchases of suits, cloaks, furs, clothing, petticoats, etc., to firms whose manufacturing plants are located outside of a zone bounded by the upper side of Thirty-third Street, Fifty-ninth Street, Third and Seventh Avenues, also including Thirty-second and Thirty-third Streets, from Sixth to Seventh Avenues.

"February 1, 1917, is the time that this notice goes into effect, so as to enable manufacturers now located in this zone to secure other quarters. Consideration will be given those firms that remove their plants from this zone. This plan will ultimately be for the benefit of the different manufacturers in the above-mentioned lines, as, among other reasons, they will have the benefit of lower rentals."

The advertisement was signed by the principal retail merchants of the Fifth Avenue section, and was endorsed by a long list of individuals,

corporations, and clubs having an immediate interest in this section of the city. There also appeared, upon the same day, extensive news items favorable to the proposal.

The deep significance of this advertisement lies in the full recognition which its signers and endorsers accord to the principle of so regulating the development of a city that all who live and do business therein may be protected in their property investments. The principle involved is known as the "zone plan" or "districting." It is neither new nor untried, yet those who have advocated its application in this country had feared that it would require years of educational effort ere the property owners in the United States would be willing to surrender the right which they now enjoy of developing their holdings at the expense of their neighbors or of the community at large. But here is a fundamental recognition of the fact that the exercise of that right destroys values, and creates a condition which subjects every property-owner to losses against which the one defence is a recognition of the principle of community values!

But the document is likewise remarkable because it advocates the exercise of a force, a sort of boycott, which, on the one hand, has been declared by the courts to be illegal, and is to be applied, on the other hand, as a constructive measure of fundamental importance to the proper economic development of a community. It attempts to bring about a condition which our feeble efforts toward proper regulative legislation have failed to accomplish.

The measure proposed is highly advantageous to New York as a whole, and to the particular district to which it is to be applied. While I am more than heartily in favor of the end sought, yet I am concerned with the method, for it sanctions the use of a questionable means, and it moreover confuses the issue. The force used is the power of individual against individual — a sort of war, in other words. It is not an act of co-ordinated community effort.

It is a characteristically American method — individualism still dominant, assertive, working for self-interest, concerned with conditions in particular, and not primarily with conditions in general. Upon final analysis, it is the same old idea of individual rights regarding the use of property that has produced our chaotic American cities. This is placing in a bad light an effort directed toward a worthy end, yet otherwise the point cannot be made clear.

We have long made use of the private restriction upon property, thinking that by so doing we could conserve parcels, or even districts, for certain uses. We are awakening now to the fact that this method not only is futile, but that it also may be harmful to the city as a whole.

At the very moment when we recognize this state of affairs (I include in this the judicial opinions regarding private restrictions), a certain group embarks upon a new policy, in which it attempts, by a very questionable method, to restrict districts of the city to certain uses. There is little fundamental difference here; originally, it was the individual who exercised the power of restricting property; the advertisement proposes the

extension of that power to a group of individuals, with not even a semblance of legal sanction.

We must not fool ourselves with the idea that this method is one whereby the serious situation created under the old method, and now recognized by those who have made use of that method, is to be adjusted automatically by economic conditions; that through this method we can integrate our complex community interests. If we do, we shall find ourselves, in a decade, in a much worse plight than we are in at present.

The proposed method is fundamentally wrong, because it assumes that individuals (either alone or as a group in accord) have a greater power than the government which represents the entire community. If this theory be sound in principle, then why cannot the city, through its police power, go as far in its regulative functions as can a group of citizens or corporations?

This is not an argument against the exercise of this power by a competent authority, after a sound, scientific basis has been reached; in fact, this or similar powers are fundamental essentials in government. It is the function of the entire community, through its government, to conserve to appropriate use the entire area of the present and future city, through regulative measures governing the erection and occupancy of buildings in every district of the city.

In this particular, we are almost impotent under the present court interpretations of statutes framed to this end. We exercise but a feeble control over the occupancy of districts. Our standards are measured by what we term economic values — values so false in many cases that the standards are meaningless. I assume that it is both a sound, social, and economic measure, to exclude any appreciable amount of industry from the area in question. It is equally sound from the social and economic standpoint, to exclude industry and business from the residential areas of the poorer class, to conserve for residential occupancy areas adjacent to parks and playgrounds, as well as areas of industry. Can one imagine an effective boycott waged by tenement-house dwellers against the intrusion of business or industry into such areas? I hardly think so.

This contrasting condition but emphasizes the fact that the suggested method is unsound in principle and dangerous to a degree. It stresses the power of capital to a point where that power usurps the function of government.

If we are to integrate our cities both socially and economically, we must provide that the entire community, not a part, be provided with such power as will enable it to assert its rights; and we must recognize, as this effort emphasizes, the fact that there is a definite field wherein the rights of the entire community stand above and dominate the rights of the individual.

At the outset, this advertisement was referred to as significant. It is the most powerful argument that can be offered in favor of districting the city. At one stroke, it sweeps aside an entire group of contentions and arguments upon the economic side (the term is used in the sense of dollar value) against the proposal to district the city. It proves the disastrous results of not so doing.

Let us take heed to this warning, and apply the principle of districting to our cities with as much skill as we now possess. Heretofore we have assumed that the greatest economic value of property would result from natural development. This, we now see, was an error. We now acknowledge that in "high class" business and residential areas the greatest economic value results from a conservation of such areas for such use and occupancy only. As to the residential areas at the opposite end of the social scale we are still in the dark. We still measure the value of such property by its possible future development for business or industry. Here we are in error, for, taken as a whole, the city is quite as dependent for its economic stability upon the conservation of residential areas of the lower class, with their recreation parks, amusement and educational facilities, as it is upon a high-class business or residential area.

We have failed utterly to grasp this fundamental truth, while business and industry sweep over these areas, as they have already swept over and blighted the Fifth Avenue district in New York, and similar districts in all our cities.

We must increase our horizon so that our vision shall include the entire range of essential values, upon the proper adjustment of which depends our ability to integrate our communities.

We must also readjust our conception of individual rights in their relation to community rights, and not leave, as we do now, the latter as a sort of nebulous bill of community rights, in which is merely set forth a number of restrictive measures against individual liberty. These restrictive measures are the community's rights, and they should be so recognized.

Backing Up Your Fire Equipment with Men.

Courtesy of October FACTORY.

Comparatively early in the safety movement it was found that mechanical safeguards alone will not eliminate accidents. The human element is large. Education in safety shares honors with safeguards in accident prevention. Isn't this true in fighting fires, both before and after they start? Some manufacturers believe that to put in the latest mechanical fire devices is all that is necessary. But shouldn't you back up your fire equipment with men? Isn't it worth while to organize your men to fight fires?

"Everybody talked about fire-fighting equipment and nobody said a word about backing up all the excellent equipment there is with an efficient inspection and fire-fighting organization," said the man who has charge of fire prevention matters in one large company in discussing what went on at a recent meeting on fire protection.

Is this man's criticism valid? He claims that the situation is not far different from that which exists in safety work. Most everyone agrees that safeguards alone will never prevent *all* accidents; a definite organization for safety is needed.

And this same man gives as one reason why the human side has been neglected, that frequently fire prevention matters in individual plants have been left with people too far down the line in an organization. It is his idea that this phase of factory management has fallen under the supervision of men like shop engineers, who understand devices thoroughly and in a corresponding degree fail to appreciate the full value of the human side. And they lack ability to manage and train men even if they do see value in backing up equipment with men.

And isn't there something in this? Isn't it a valid criticism of fire protection procedure in many plants?

Inspection is the place to begin, in the opinion of one authority. The best of sprinkler equipment and thermostat systems will not detect accumulations of refuse conducive to spontaneous combustion — at least not until a resulting fire operates these admirable devices. Even if a factory is small, assign to some one person the inspection of the plant aside from his other duties and make it daily, this man says.

An investigation carried on by *Factory* seems to indicate that most plants which have inspections from a fire prevention point of view make them once a week. Some make them daily and a few seem satisfied with the insurance inspector's trips "once every three or four months."

THESE EMPLOYEE FIREMEN KNOW HOW

When drills of the employee fire brigade call for the actual use of equipment, the fire fighting apparatus is well backed up with men that know how.

At each of the plants of the International Harvester Company, for instance, there is an inspection daily, including Sundays, by a "chief of fire and watch" who has no other duties aside from fire prevention. In addition, there is a general chief who inspects all the works.

Some concerns have a periodic inspection of the fire apparatus itself backed up by a more frequent inspection of general conditions from the fire risk viewpoint. For instance, the Parlin and Orendorff Company has its fire chief make a semi-monthly report to the superintendent on the condition of the fire brigade and its fire appliances. In addition, the fire regulations call upon the heads of departments "to examine each morning the water pails, sand pails and water barrels and note if they are filled and in position; also to note as to cleanliness in the way of paper, rubbish or refuse collected or found near steam pipes or in any portion of the building, and see that same is disposed of."

It will be argued that this arrangement has the fault that it distributes the responsibility among a number of people whose main duties are quite aside from any routine of fire prevention. Then, too, an outside inspector will be less lenient of lax conditions in a department than the head of that department.

From a control point of view there is much to be said in favor of centralizing authority for fire inspectors instead of subdividing it. Often this centralized authority is given considerable power. For instance, the fire chief at the Goodyear Tire and Rubber Company inspects plants and sends written notices to departments where any fire hazard or blockage

of fire apparatus or doors is noted. The fire chief has absolute authority to levy a fine against the department expense budget where his orders are not carried out.

The rather novel scheme of inspection at the plant of Deere and Company is described in a letter from A. H. Head, the superintendent, who writes, "We have a weekly inspection made of all fire apparatus by one of eight men, each of whom is an executive in the factory organization, such as chief engineer, master steamfitter, electrician, master mechanic, production superintendent and chief inspector." This, of course, has the advantage of focusing at intervals the special knowledge of each of these heads upon the inspections.

As several of those questioned brought out, good housekeeping is the one thing never to be lost sight of by fire inspectors, whoever does the work.

An interesting combination of duties is worked out at the National Tube Company's plant. "Instead of night watchmen," says the Bulletin of the American Iron and Steel Institute, "a paid night fire department patrols the plant, combining the duties of watchman service with trained fire protection. . . . The day watchmen inspect and report daily to the chief of the fire department on the condition of all fire protection equipment."

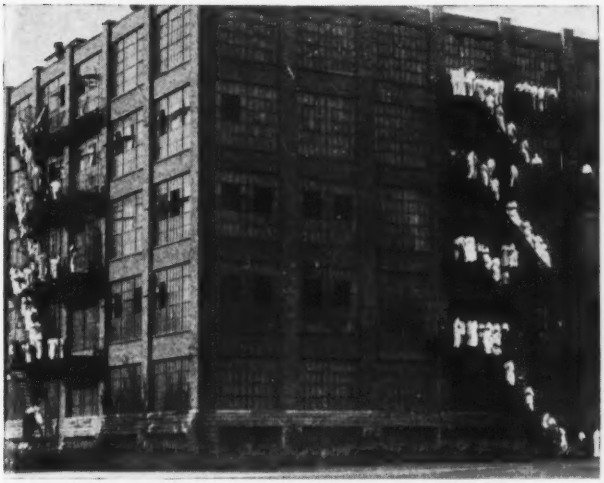
In several plants, the investigation showed, fire inspection falls to the lot of the safety inspector. Such an arrangement avoids the duplication of effort which otherwise might result. When it comes to the smaller plants, naturally the superintendent does this work. But even here some argue that inspections should be made by someone "without so many irons in the fire" if but fifteen minutes is taken each time an inspection is made.

With the best of fire protection equipment well backed up by careful inspection, isn't the personal element still present in that a force of specially trained men is needed to realize the most value from the equipment?

The concern that bought a piece of land adjacent to its plant and presented it to the city on condition that a city fire station be built there, probably has no fire brigade of its own. But every plant is not so pleasantly situated. Private fire brigades, while they may not be dignified by that term, are considered necessary in many factories. Very seldom do companies have paid firemen without other duties. Almost always they are regular workmen who have received special instruction on fire fighting. One concern at the outset in its booklet on its fire brigade states as the object "to allay excitement and alarm in case of fire." And then secondarily comes, "to protect and save property."

The personnel of private fire brigades varies according to schemes peculiar to different companies, but almost always there is the intention of drawing men from a variety of departments, so that wherever a fire occurs some one of the brigade is early on the scene at a time when his special knowledge of what to do is particularly valuable.

In the Canton plant of the American Bridge Company six of the foremen compose the fire brigade. At another plant the safety com-



QUICK EMPTYING OF A FIREPROOF PLANT

This is not a posed time-exposure, but was made from a "movie" film taken at a regular fire drill at one of the plants of the Eastman Kodak Company.

mittee serve in that capacity. The American Iron and Steel Institute through its bulletin shows that at the Harrisburg Pipe and Pipe Bending Company, "There are twenty guards on duty day and night through the plant, who also constitute the fire brigade, all of whom are assigned to certain stations through the plant."

While in very few plants are firemen employed having no other duties, an appreciable percentage pay extra for this service, even if all drilling is done on company time.

The B. F. Goodrich Company has fifteen men in a regular fire department and they expect soon to increase this number to twenty. These men sleep at fire headquarters in the plant and eat at nearby restaurants. They are employed as watchmen and roundsmen.

Generally, payment is made contingent upon attendance at drill, and sometimes takes the form of a fixed payment of twenty-five or fifty cents for each drill attended.

Some companies base the pay upon the number of runs made, whether on test calls or for actual fires. This of course is practically the same thing as figuring it at so much each drill.

Where the members of the fire brigade are expected to live near the plant and respond to fires day and night, a straight extra wage is generally allowed.

To *start* a scheme of any sort is only a part of the problem. To keep it going is often the biggest end of it. And it's true of fire brigades. How to sustain interest is a question that the twenty-five or fifty cents a drill

before mentioned will not answer. Many concerns stimulate interest by means of competitions between departments or factories. This, for instance, is the case at the International Harvester Company. Recently, men were taken from the Akron, Ohio, plant to the Auburn, New York, factories to compete. In this concern there is a challenge cup offered for competition among the Eastern works and another among the Western.

The investigation shows that drills of the fire brigade, like foremen's meetings, are better held during working hours. At least, most concerns so time their drills. There may be advantage, too, in holding drills while the other employees are at work. Thus responding to a real call has less panic possibilities than might otherwise exist. As in the case of inspections, once a week seems to be the usual frequency of drills for fire brigades.

The question, "Who trains your firemen?" brought a wide variety of answers. They are ranged from "nobody" to superintendent, and included chief machinist, chief engineer, safety engineer, plant inspector and fire chief. Here perhaps is the weakest point as brought out by this investigation. While it may be that in each case the person designated in that particular plant is the one best qualified to train the fire fighters, it is open to question.

Nobody doubts the value of fire brigades, but not all plants need them if the employees as a whole receive proper fire instruction. But brigades in every plant should tell its employees something of the conduct it expects of them at a fire. It is merely what a good organization for education in fire prevention and protection would bring in any factory.

In many plants education is a powerful factor in fire fighting. At the Arlington Company's plant the motto, "Protect from fire; then make Pyralin" has been so deeply impressed upon the minds of the employees of the plant that if any infringement of even the slightest rule against fire should be committed by a new employee, he is immediately cautioned and shown the serious side of the offense by some of the other employees.

Some concerns use the scheme followed by B. F. Avery & Sons in getting all fire-fighting facts before the employees. This company issues a booklet setting forth clearly and concisely what to do at a fire. In fact, it is a "Who's Who" and a "What's What" of fire prevention in that plant. To insure that the booklet will be preserved, an identification card is printed on the inside of the back cover and a chapter on how to prevent fires in the home is included.

If a factory is small, an occasional questioning of individual employees as to the location of the nearest fire box, extinguisher and fire hose is far better than no instruction. Some small plants give special instructions to a few sitting nearest to an extinguisher or special apparatus as to its operation.

Even if buildings are single story and easy of exit, there are precautions that many could take affecting at least a few in the plant. For instance, the Baker-Vawter Company writes, "On account of the fact that the buildings are all on one floor, are well scattered, and the number of workmen in each department is comparatively small we have not developed

any fire drill to speak of, although the engineer, fireman and millwright are fully informed of what to do in case of fire."

Educational campaigns unless they are continuous do not have a lasting effect. Mr. Vawter points this out when he says that changes in employees form the greatest drawback to efficiency in the fire protection of a plant.

More instruction on fire matters when men are hired is one way of overcoming this, but not so good probably as a continuation of educational campaigns to the working force as a whole.

Building Inspection by Firemen.

Suggestions for Systematic Procedure.

By James Crapo (Member N. F. P. A.)

Battalion Chief, Chicago Fire Department.

When a fireman is called upon to inspect a building there are three points of fundamental importance presented for his consideration; if proper precautions have been taken to enable all employees to reach the street level quickly and directly, what possibilities are present for confining a fire to a limited area of the building or even to the entire building, and the accessibility of the building to the fire department. With these cardinal points in mind the inspector will first make his way to the roof; the starting of an inspection from this point is not only customary, but is founded on good reasoning, as the roof affords a much clearer mental picture of fire sections, exposures, and accessibility than can be gained from starting in the basement of the building and inspecting the entire building without being sure of which interior walls are fire walls. Once on the roof the inspector will concern himself with the fire walls dividing the building into sections, if there are any such walls, their height and thickness above the roof as well as the height and thickness of the exterior walls above the roof both being of major importance, and especially so when the building in question is exposed by buildings of equal or nearly equal height. Quite frequently the inspector will find that the plant may be cut up into two or more distinct fire sections but that a continuous wooden or hollow metal cornice makes it possible for a fire to spread from one section to another or that a combustible elevator head is located near one of the parapets on the interior fire walls so that a fire could jump directly to it. These are features which must be carefully noted. If the building is equipped with automatic sprinklers there will be a gravity tank on the roof and possibly the pressure tank will also be set on the roof in a pent-house. See that the gravity tank is full of water and carefully investigate both the metal hoops on wooden gravity tanks and the steel

or iron supports of the tank if same is set on a trestle; all this iron work must be thoroughly protected by mineral paint. Then look at the gauge on the pressure tank and see if it registers at least 75 pounds pressure. If the building is not sprinklered it may be provided with an inside standpipe, in which event there is likely to be a gravity tank on the roof for primary supply, the same remarks applying to this tank as to the sprinkler gravity tank. Before leaving the roof also investigate the motor in the head of the elevator shaft, note the condition of the wiring, if oil is permitted to soak into the wooden flooring under the motor, and also note the condition of the elevator supports. After seeing that fire escapes are all well painted, that they have ladder extensions to the roof, and that outside standpipes in connection with these fire escapes are well supported, roof valves closed and threads well oiled, descend to the top floor. On this floor, as well as on all floors below, note if there are any communications through the interior fire walls or to adjoining buildings, how they are protected, and the condition of the fire doors. Also observe if stair and elevator shafts are enclosed, in what material, if the openings to shafts are provided with self-closing or automatic fire doors, and if the doors to the elevator shaft are of the type which close automatically when the elevator leaves the floor level. If automatic trap doors are provided in the elevator well, make inquiry at the office and find out if they are regularly tested. See that "Fire Escape" signs are provided at all fire escapes and "Exit "signs at all other means of egress, and that a gas or electric light enclosed within a red globe is provided at each such sign if plant is occasionally or regularly operated after sun-down. Also note if adequate aisles are provided leading directly to all means of egress, if there are any obstructions on stairs and fire escapes, and if all doors open outward and without the use of a key. In passing it might also be well to observe that when sills of windows opening upon fire escapes are more than two feet above the floor, a stair should be built to the sill from the inside. The inspector must also concern himself with the amount of portable apparatus on the various floors, such as liquid chemical extinguishers, fire axes, water barrels and pails, and see that a tag is attached to all chemical extinguishers bearing the date upon which same was last filled. If there are one or more inside standpipes, see that hose is sufficient in length to reach all parts of the floor, that hose is attached to standpipe and supported on self-releasing brackets and that all hose is in good condition and fitted with smooth bore brass nozzles. Also see that floor load and "No Smoking" signs are posted. Under the general heading of "Housekeeping" the inspector will note what provision is made for the care of rubbish and sweepings, if metal cans with tight fitting metal covers are provided for same, and what final disposition is made of it, if rubbish is allowed to accumulate behind steam pipes, if the pipes themselves are clear of all woodwork both in regard to supporting racks and in passing through floors, if metal cans with self-closing covers are installed for oily rags and waste, if metal pans are provided under metal working machines to catch oily metal shavings or if sawdust is used for absorbing oils from

floors or used in wooden spittoons. Among the more prolific sources of fire in factory buildings is the presence of dummy elevator shafts which are frequently used as catch-alls for rubbish. The line shafting should also be carefully noted to see if same is well aligned and the bearing running cool, and note if drip cups are provided under the hangers. The disposition of ashes from stoves, etc., should be noted as well as the practice of hanging drop cord electric lights over nails and gas pipes, the latter being a very dangerous and a very common custom. Also observe if there are any swinging gas brackets, and if stationary brackets have ample clearance to combustible ceilings. Besides bearing in mind these points the inspector, as he passes from floor to floor, should take note of all hazards arising from the various processes of manufacture and if such processes are carried on in the open, or are partitioned off in fireproof or incombustible rooms with standard fire doors on openings. The uses of various highly volatile oils are common sources of hazard in a great number of factory buildings and the inspector should pay particular attention to the kind and quantity of such oils handled, as well as to the manner in which they are handled and their proximity to open lights or fires of any kind. Heat devices of all kinds must also have the consideration of the inspector, their setting, construction, maximum temperature and clearance to combustible material being of paramount importance. Upon arriving in the basement note the setting of the boilers, their clearance overhead and at sides, as well as the clearance of the steam dome to the ceiling, the construction of the ceiling immediately over the boiler and the construction of the smokepipe (whether metal or brick) and its clearance to combustible material. Also make note of how ashes are handled, and if waste paper and rubbish and coal are allowed to accumulate either around the boilers or the hot water heater If there is a steam or electric fire pump in connection with the inside standpipe system, note if it is automatic in its operation and inquire of the engineer as to its capacity and pressure. Lastly, locate all floor drains and see if they are unobstructed and indicated by signs, and request the engineer to oil all valves and hose connections on outside standpipes, and as you leave the premises note the best method of entering in event of a fire at night. After leaving the building, the last thing to be accomplished is to locate all steamer connections to sprinklers and inside standpipes, and to see that they are all properly oiled and capped with non-corrosive plugs.

Public Fire Departments.

By George W. Booth (Member N. F. P. A.)

Chief Engineer, National Board of Fire Underwriters.

Of an importance which increases with the growth of a community and of the values involved, is the form of the organization of the fire department. In times past, practically all departments were volunteer organizations, survivals of the day when a few men would organize for mutual protection, with little regard for the property of others unless forming an exposure to their own. These volunteer departments, in the larger places, have mainly given way before the demand for better trained men and more prompt and efficient work. The next step forward was a part-paid call system with or without some permanent men paid full time; this system has been extensively used in the New England states and has given excellent service. However, the call system is being rapidly replaced, especially in the larger places, by full-paid permanently employed departments. The reasons for this are somewhat the same as those for discarding the volunteer system. For example, as an alarm of fire calls out many workmen, causing a loss to their employers with seldom any direct benefit, the objections of the employers make it harder each year to obtain good men for the fire service. The recent introduction of automobile apparatus has so increased the speed of response that unless men are at the station they cannot respond with the apparatus and their delay in reaching the fire is still more pronounced than with horse-drawn apparatus; discipline cannot be as well maintained and drills are not as complete nor as often held, with a consequent lack of efficiency in the department; last, but not least, a call or volunteer organization does not readily lend itself to fire prevention work, as does a paid department. Further consideration will be given some of these items, as being of first importance in securing the highest department efficiency.

In fire departments, as in other branches of city government, political domination and petty graft have prevailed at various times. It goes without saying that the appointment of officers and men for other reasons than their fitness for fire service will almost inevitably result in demoralizing the force and decreasing its efficiency; probably the most serious effect is obtained when political debts are paid in the appointment of chief officers. Only men of proven ability should be given important positions; in some cases, competent chief officers of the smaller departments have been appointed to similar positions in the larger cities, and

this scheme has worked out well. For all officers long tenure of office is desirable, to secure proper familiarity with local fire conditions and the general duties of the position; to obtain this, as well as to eliminate harmful political changes, the appointment of all officers for indefinite terms, with removal only under charges, is desirable. The method of appointment best adapted for any city depends largely upon the size of the city and local conditions. Civil service methods have been in some cases rather freely criticized, but it is doubtful if anything better, or in fact as good, could be substituted. Where civil service is properly applied, the past record of applicants is considered and they must successfully pass a rigid physical examination before taking the mental examinations. While the mental examination may bar out some otherwise desirable applicants, yet in the large cities there is no lack of applicants and it is readily practicable to make physical requirements such that all the men getting on the eligible list shall have the making of able-bodied firemen. The varied emergencies and requirements of modern fire department work are best met by men capable of passing reasonable mental as well as the physical examinations, rather than by men whose chief asset is mere strength.

When the eligible list is established, appointments should be made by the chief rather than by a council committee or the mayor, and appointments should not be made permanent until the officers have had opportunity to observe the work of new men at fires and determine whether they will make successful firemen. Once appointed, they should be made secure in their position during good behavior and efficient service.

For retirement, the National Board of Fire Underwriters has recommended that members be retired from active duty on reaching the age of sixty-two years, unless at that time they are unusually efficient. Sixty-two years is the age for retirement from the United States Army and Navy. The exemption from this rule of members of unusual efficiency enables the department to avail itself of the accumulated experience of the higher officers, who should have no manual labor to perform. In connection with requiring members to retire on account of age, there should be provisions for pensioning men for long service or disability.

In the ordinary full-paid department, the men will be collected in a comparatively few companies of sufficient strength to man all the apparatus at the station. If call men or volunteers are included in the department, then enough full-paid men should be assigned to get the apparatus to a fire and get to work. In a part-paid engine company, for instance, the engineer, two drivers and one other member, preferably the captain, should be full-paid, so that at least two men will be on duty during meal hours, enough to get the apparatus to the fire; for a hose or ladder company, at least two men must be full-paid. This does not allow for days off or sickness, for which permanent substitutes should be employed, who will shift from one company to another to fill in.

For a full-paid department, the National Board recommends that at least seven men be present at all times in each engine and ladder company in mercantile and manufacturing districts and five men in other

districts. For hose companies the men should number at least five and three, respectively. In an engine company the men will be as follows: Engineer, one officer, two drivers and three hosemen. With a motor pump only six men will be required as the minimum on duty at all times.

In some departments the drivers are allowed to stay idly with their horses while the few hosemen struggle to carry hose up stairs and ladders. This is obviously poor practice, but has been a difficult one to overcome.

The requirement of seven men present at all times in important engine companies may appear low; on the contrary it is rather higher than obtains in many cities, as men get ten to fifteen days' annual vacation, four to seven days off per month, and three or four hours for meals. Consider a fourteen-man company, where men get two weeks' vacation, one day off in five and three hours daily for meals, a common arrangement. During a large part of the time one man is on vacation and three on days off, leaving ten on duty for the day; then during three hours the company is reduced to six men and during six hours to seven men, if men go in three shifts.

Two Platoons.

The movement for organizing fire departments on the two-platoon or two-shift plan has attained considerable strength. In cities where the actual day strength of companies is about one-half the paper strength, the two-platoon plan would apparently not appreciably decrease the effective force and it appears that the total strength available for serious fires may be even greater than with the single-shift plan, if proper provision is made for their notification and response on second and greater alarms; objections raised by fire chiefs to the two-platoon system are mainly that discipline will be affected and that the men will be in poorer condition for the service, particularly those on night shift. There may be considerable force to these objections in departments where conditions render it difficult to maintain discipline in any case; by a strict enforcement of the rules, as in Omaha, in which city the two-platoon has been in existence since 1907, they appear to have been mainly eliminated. More serious objections are the lack of men for inspection work and the increased cost of such a system, amounting to about one-third more than the single-shift system; this last may result in a decrease in other expenditures desirable to meet the natural growth of the city.

Organization Here and Abroad.

The number of paid men per thousand of population in the larger cities of this country averages about 1.25, ranging from 0.75 to 1.5, depending upon the density of population, the extent of the high values to be protected and the financial condition of the city. These men are organized in companies having about 12 members, either for an engine company or a ladder company, with usually only one or two companies in a house. An interesting comparison on this point is the practice in Europe, where companies are grouped; the County of London has a fire force of 1,365, for a population of 4,873,000 or a ratio of 0.28 per thousand of population. These men are organized into a total of 82 companies, with an average of

16 men per company. Similar figures for Berlin, Germany, show a total of 1,040 men, organized into 20 companies, for a total of 2,123,000 population, with a ratio of 0.49 per thousand population and 52 men per company. For Milan, Italy, the figures given show a fire force of 221 full-paid men, organized into 6 companies, for a total of 580,000 population, with a ratio of 0.38 per thousand population and 37 men per company.

Salaries.

Since the salaries paid in this country are much higher than those paid abroad, the per capita cost for maintenance is still further out of proportion. The salaries paid the various grades of firemen in the larger cities of the United States range from $900 to $1,400 a year and the per capita expense will average over $1.50 with a maximum of over $2.50. In London, the yearly pay will range from about $300 to $450, with clothing in addition; the per capita maintenance expense of the fire department is 27 cents. In Berlin, Germany, the per capita expense of maintenance is 26 cents, and in Milan, Italy, about 29 cents.

In considering the number and location of companies, the topography, street paving and general character of the city must be considered; Pittsburgh and Cincinnati require a considerably larger number of companies than do some other large cities not having such steep grades and more compactly built. The introduction of automobile apparatus has offset some of the disadvantages resulting from uneven topography, and also influences the number of companies, through making aid from surrounding communities more readily available; in this last respect it is considered that any needed department strength, over that necessary for proper local distribution, which must be provided to handle a serious fire in the congested value districts may be offset to a large extent by the outside aid available within 30 minutes.

For proper quickness in response it is estimated that with automobile apparatus, an engine or hose company should be within ¾ mile of every point in high value districts and a ladder company within 1 mile; in residential districts about twice these distances will give satisfactory service; for horse-drawn apparatus the distances should be two-thirds of those given above.

Equipment.

The equipment for a department is largely dependent upon the topography of the city, the character of the buildings and condition of the water supply. Where the water works system is so designed as to provide an ample supply of water at a minimum hydrant pressure, during draft, of seventy-five pounds or over, the fire department can be kept upon a direct-hydrant stream basis until buildings of over four stories begin to be numerous. One or more engines in service or in reserve may be desirable to protect the higher buildings or those too far from the hydrants for effective hydrant streams; for cities of over 30,000 population, it is advisable to have about one-third the companies provided with engines, to furnish the more powerful streams. Frequently some of the residential sections

will be at considerably higher elevations than the business district and companies in these localities must be equipped with fire engines.

Chemical apparatus should be the main reliance for ordinary fires; in some cities, 75 per cent or more of the actual working fires are controlled by chemical streams. In recent practice the automobile combination chemical and hose wagon has been found an exceedingly valuable apparatus and is largely superseding both the horse-drawn combination wagon and the straight chemical.

Steam fire engine construction has become quite well standardized and these machines have reached a comparatively high degree of reliability. However, the application of the gasoline motor to fire service offers such advantages that in the past year or two comparatively few steam fire engines have been sold, and many of these have been equipped with motor tractors to replace horses.

Defects of Early Auto Apparatus.

The earlier types of gasoline pumping engines were adaptations of touring cars or commercial trucks; the hard service required of such apparatus in pumping and in running over all kinds of roads, often in the hands of men poorly trained for the service, introduced conditions more severe than the machine could withstand. The defects developed by these earlier pieces of apparatus are being gradually eliminated by a careful design along the special lines necessary for such service.

In regard to the pump, for all except village service, two good fire streams should be available under ordinary working conditions, which, with the modern use of hose with smooth lining and nozzles of good size and discharging capacity, means an actual delivery of about 500 to 600 gallons. With all pumping apparatus the slip may be expected to increase with use, and other conditions will tend to reduce the capacity of the pump, so that a capacity of 700 gallons is not too much for most cases, and for metropolitan service even larger capacity may be desirable. City service at serious fires, when the maximum engine capacity is needed, will most often call for such lengths of hose lines and sizes of nozzles as to require an engine pressure of 120 to 150 pounds, with pressure up to about 200 pounds or more for fires in high buildings or for suburban service.

Motor Pumping Engines.

Various types of pumps have been used, and there are a number of different methods of connecting the pump to the engine. The types in use include reciprocating piston pumps, both single and double-acting, rotary cam or gear pumps, and pumps of centrifugal or turbine design, either of multi-stage or with two or more single-stage pumps working in series. Machines embodying each type of pump have been successfully developed. Reciprocating pumps usually require a more complicated power-transmission system than the others, and to work successfully with the range of pressure desired, have been provided with transmission permitting two speeds; this type of pump is, however, reliable, efficient and easily kept in good condition, if properly designed and given competent attention.

The rotary pump, because of its compactness and the simplicity with which power may be transmitted to it, is well adapted to this service; some of the early makes, however, were not well designed for efficiency, and others were not able to operate at high pressure; the wear resulting from service, unless properly cared for in the design, will occasion high slip and impair efficiency.

Although used extensively in Europe, the centrifugal pump was not at first successfully developed for the extreme range of fire service required in this country. Though handicapped to a slight extent by the need of some special priming device to secure suction for the pump, the advantages of this type of pump were sufficiently great to interest several designers, and one fire apparatus manufacturer has adopted this type as his standard; its ability to withstand hard usage, its simplicity and ease of repair and its property of automatically regulating discharge and pressure are features tending to make it a most desirable type for fire service.

Requirements for Fire Service.

With any type of pump, the requirements desirable for fire service are flexibility of operation, that is, ability to operate over a wide range of pressure and the power required for good fire fighting; the National Board has recommended that the test be such as to obtain the full rated capacity of the pump for two hours against a net pressure of 120 pounds and one-half of the rated capacity for one hour against a net pressure of 200 pounds; in some cases this last clause is changed to provide for a half-hour run at one-half capacity and 200 pounds net pressure and a half-hour run at one-third capacity and 250 pounds net pressure.

There are a number of automobile pumping engines now on the market which compare well in point of reliability with the steam fire engines, but there are other makes which have not passed the experimental stage and have not proved their ability to operate successfully for long periods and under the varying conditions of fire service.

Equipment for Engine Companies.

The ideal equipment for an engine company in a city able to afford it consists of two pieces, a pumping engine and combined chemical engine and hose wagon, the latter ordinarily known as a combination wagon. A good arrangement in small or medium-sized cities is to have about half the companies equipped as above, which will furnish adequate chemical service, and the other half equipped with combined pumping engine and hose wagon. This latter piece of apparatus must, of course, be so manipulated at a fire that after the one or two hose lines needed are stretched from the hydrant to the burning building, the engine will reach the hydrant and connect its suction as quickly as possible; there will naturally be somewhat more delay than if a separate engine and hose wagon are provided, but this delay should not be more than two or three minutes in most cases, even when two lines of hose are laid, as shown by tests of a crew trained to the work.

Triple Combinations.

The triple combination, as it is usually called by manufacturers, consists of a combination of pumping engine, chemical tank and hose body. Most fire chiefs are agreed that this piece of apparatus is not a desirable one for general installation, for the obvious reason that its use in furnishing chemical service precludes its pumping from a hydrant or other source of water supply, at least without considerable delay at what is likely to be a critical moment; and also for the further reason that too much equipment is carried on one set of wheels and is lost to service in case of disablement. However, it has a place in localities where the pump is very seldom needed, as, for instance, in cities where the water pressure is sufficient in most sections for effective direct hydrant streams, but there are occasional high elevations or weak spots on the water distribution system and the ordinary hydrant pressure is inadequate. It will also take the place of a reserve engine for use at serious fires in high value districts.

The main points to be considered in purchasing automobile hose wagons are believed to be covered by the recommendation included in most of the National Board reports, as follows:—Automobile hose wagons to have divided hose bodies with a capacity of at least 1,000 feet of hose when carrying equal amounts of 2½-inch and 3-inch hose. Motors to be capable of attaining a speed of 30 miles an hour, and of covering 20 miles in an hour over paved or macadamized streets having such grades as the apparatus is likely to encounter in service.

Most of the earlier automobile fire apparatus was fitted with pneumatic tires, and some of it is still so equipped; but some form of solid or cushion tire has come to be considered by most fire chiefs and manufacturers as preferable, from the standpoints both of safety and economy.

The Hose Supply.

The question of hose is often one requiring considerable argument on the part of the chief to convince the city fathers of the need of money for an adequate supply; in addition to the hose on each wagon in service, a complete extra shift should be provided at each house in order that after use it may be shifted, cleaned and dried. If not used, hose should be shifted on the wagons at least every two weeks, in order to prevent mildew and cracking of the lining.

In case hose is burned or otherwise destroyed, or for large fires where wagons must come back to reload, the reserve hose is also needed. Investigation shows that the average hose lines in city fire department practice are somewhat over 400 feet in length; therefore, to provide two average lines, each wagon should carry about 1,000 feet of hose. For wagons accompanying large engines able to pump over 800 gallons, or for outlying districts where long lines are common, 1,200 to 1,400 feet are better, making three ordinary lines or one long line for places at a distance from hydrants.

Life of Hose.

Good quality hose should have a life of about 7 years, and annual purchases should be made on the basis of replacing all hose every 7 years.

That over 5 years old should be transferred to the outlying companies, so that in sections where a burst line would have serious results there will be only new hose.

Serviceability of Three-Inch Hose.

The 2½-inch hose is best adapted for regular use, but if long lines are laid or large streams required, the 3-inch size is better. With a standard 1⅛-inch fire stream flowing, the friction loss in good 2½-inch hose is fifteen pounds per 100 feet. Thus with 800 feet of 2½-inch hose, 120 pounds pressure is needed to overcome friction and 45 pounds for the nozzle pressure, so the engine must work at 165 or 170 pounds. If hose is attached to a hydrant, the pressure is limited probably to 80 or 90 pounds and larger hose or more lines, siamesed, must be used to produce a stiff stream. Three-inch hose will convey the same quantity of water over two and one-half times as far as 2½-inch hose, with the same friction loss; for a standard 1⅛-inch stream with 800 feet of 3-inch hose only 94 pounds pressure will be needed at the engine or hydrant. By laying two lines and siamesing into one near the nozzle, the friction loss may be still further reduced, to about one-fourth the loss with a single line. In other terms, 108 pounds engine pressure will push a 250-gallon 1⅛-inch stream through 400 feet of 2½-inch hose, or 1,000 feet of 3-inch hose, or 1,500 feet of 2½-inch hose siamesed. Three-inch hose is heavy and stiff and not adapted for ordinary use in buildings or on ladders, so the best practice is to arrange the hose in wagons in two sections so that the 200 to 300 feet next the hydrant shall be 3-inch and the rest, which may have to be moved about, shall be 2½-inch. The National Board has made the following recommendations: That each hose wagon shall carry at least 200 feet of 3-inch hose for outside leads. For high value districts, that eventually each wagon shall carry equal amounts of 2½ and 3-inch hose, in two sections.

Where 2½ and 3-inch hose are in use it has been found a great convenience to equip the 3-inch hose with 2½-inch couplings, in order to eliminate delays from mislaid reducers and varying couplings. Contrary to general impression, the use of smaller couplings does not appreciably affect the friction loss, so that for ordinary fire streams the difference in pressures from straight 3-inch hose or 3-inch hose with 2½-inch couplings is not noticeable. Therefore the National Board has recommended that both 2½ and 3-inch hose be equipped with 2½-inch National Standard couplings, properly beveled.

Annual tests of all hose over two years old, and of any others that show defects, should be made, with a test pressure of 200 pounds.

For use at serious fires, where additional lines are needed, many departments maintain their spare hose rolled and ready for quick loading on any wagon which may be sent back for it. Of greater value is a loaded reserve hose wagon, preferably carrying 3-inch hose, kept in some fire station centrally located with respect to the high value districts. This wagon should have a turret pipe, to give powerful streams; and in addition to this, a sufficient number of other apparatus should have turret pipes,

deluge sets and cellar pipes to permit the use of a sufficient number of good streams to hold a spreading fire.

Buildings Over Four Stories.

Cities having buildings over four stories high must make some provisions for fighting the fires in the upper stories. The use of building standpipes for this purpose, either from the lower floor of the same building or from a building across a court or narrow street, is recognized as being good practice, but in addition to this some apparatus must be provided for use where standpipes are not available. In the smaller cities, a ladder pipe attached to the aerial ladder gives good service, and if equipped with 3-inch hose for the ladder lead, with a siamese at the lower end, streams up to 2-inch can be used, if the ladder is provided with a proper locking device. For the larger cities a water tower is necessary, and in some cities such apparatus is called on first alarms; its response should be provided for on the running card in every case, and frequent drills should be had with it to familiarize the men with its proper handling.

Extensive minor equipment is a necessity for any up-to-date department; in general, most of this is carried on the ladder trucks, as it is the duty of the laddermen to use it; however, hose wagon equipment should be sufficiently complete to permit the men on the wagon to work independently of the ladder trucks for all residential and other small fires. Besides a complete set of nozzles, including both shut-off and open tips from ⅞ to 1¼ inches in diameter, suitable forcible entry tools, chemical extinguishers and short ladders should be carried on each hose wagon. Ladder trucks and most of the hose wagons should carry salvage appliances, particularly waterproof covers.

The Fire Station Problem.

The question of suitable fire stations does not ordinarily affect fire service directly; poor arrangement for the apparatus, narrow streets in which to turn out and improper locations of sliding poles, etc., are features sometimes found. Unsanitary arrangements and dilapidated buildings affect the health and spirits of the men to a certain extent and should be corrected.

Repair facilities are necessary for the proper upkeep of apparatus, particularly in the larger cities where apparatus gets considerable use. It is better to have this handled by the department, and in many places all minor repairs are made by the men while about the house. A good supply of spare parts is becoming of great importance with the general use of automobile apparatus. To take the place of apparatus being repaired, it is necessary to provide a certain number of spare pieces, and this is also of greater moment with a department equipped with automobiles. It is estimated that provision should be made to have at least one fire engine out of ten in reserve, with one out of five for automobile pumping engines; for hose wagons, the number in reserve would be one in fifteen and one in ten, respectively, for horse-drawn and automobile.

New Apparatus.

In the purchase of new apparatus, particularly pumping engines, adequate tests should be made, and similar, though not so severe, tests of repaired apparatus. For pumping engines, these tests should be along the lines of those conducted by the engineers of the National Board of Fire Underwriters. In these tests, each engine is run for 20 minutes or more, under such conditions as would be met with at a serious fire; the speed is noted and actual discharge measured by means of Pitot tube and gage. By means of this test, there may be determined the capacity and condition of the engine, the ability of the engineer and the quality of the fuel, and the value of the test consists largely in demonstrating to fire department officials the actual condition of the engine and the best methods of correcting such defects as are disclosed. Such tests have so commended themselves to a number of fire departments as to be adopted as part of their regular operation. A pamphlet has been issued by the National Board describing methods of testing and appliances necessary, and copies of this pamphlet have been distributed to members of fire departments all over the country.

This pamphlet contains also tables showing friction loss in hose, and the pressures necessary at engine or hydrant to maintain given nozzle pressures with various lengths of 2½ and 3-inch hose. These tables demonstrate strikingly the futility of long lines of 2½-inch hose and the advantages of using siamesed lines and 3-inch hose where heavy streams are required.

Effect of Discipline.

Discipline greatly affects the general condition of a department, and is in itself greatly affected by political influence in many cities; semi-military discipline is usually exacted, including proper deference to superior officers. In volunteer departments the lack of discipline is very noticeable and often results in serious loss; fortunately it is rather uncommon for the lack of discipline to be so marked today as in the past, when it resulted in companies fighting each other instead of the fire.

Response to Telephone Alarms.

The required response of apparatus to any fire also depends upon the character of the city. In general, every alarm should be considered as indicating a serious fire, and the response made accordingly; in many cities, only one company is sent to answer a telephone alarm, the chief arguing that in nearly every case such an alarm has been for a fire which could be handled by one company and that it is not well to send more apparatus than is needed. This contention is obviously erroneous, as alarms for many extensive fires are first sent in by telephone. As a general rule, at least two engine or hose companies should respond to every alarm of fire, not only because both may be needed immediately upon arrival, but also to offset the possibility of no apparatus arriving because of an accident. In high value districts, as values and congestion increase, the response should be strengthened; in New York, to many of the down-

town boxes, five engines respond on first alarms, and an average of four for each succeeding alarm. One or more ladder trucks should be sent to all sections having buildings which cannot be reached by the ladders on the hose wagons. To get a uniform response, a properly prepared running card is essential, with provisions for companies to fill vacated houses or cover territory left without apparatus. It sometimes happens that response may be too heavy, too many of the companies going out to leave proper protection against a second fire; this is particularly likely in a volunteer department.

Drills and Training.

No feature of fire department operations offers a more interesting field for study than those of drills and training and of fire methods; by means of the former the men are kept in good physical condition, and prompt and proper action is secured. A number of the best departments maintain drill schools where new members are sent for a regular course of instruction,and details from the different companies drill at regular intervals to maintain their proficiency. It is recognized today that to enable proper drills to be held, a drill tower, equipped with the necessary appliances must be provided.

A German Critic.

The methods employed in extinguishing fires vary somewhat in different cities, and there is a wide variation in some respects between practice in this country and abroad. Herr Reichel, the head of the fire department of Berlin, Germany, has recently been quoted as saying that American fire departments are "extinguishing organizations, pure and simple"; and if this is so, it is largely because there are seldom any laws or ordinances which permit them to be anything else — to take up the other functions of fire prevention, the discovery and elimination of fire hazards and looking after the installation of devices to prevent the spread of fire. In some cities, a beginning has been made in this direction; in others, fire chiefs have been able, through personal popularity or the assumption of authority, to secure considerable improvements, even without the aid of adequate regulations, but this is hardly feasible in the larger cities.

The existence and continuance of conditions tending to produce a high conflagration hazard, have thus made necessary the development of the purely extinguishing function. With the increase in extent and in hazard of high value districts, there comes an increasing demand for fireboats and high pressure systems, to check the spread of serious fires and prevent conflagrations.

Chemical Streams.

Nearly all fire departments use chemical streams to a greater or less extent, some of them from straight chemical engines, more often from combination chemical and hose wagons; these chemical lines, for use inside buildings, are backed up by lines of large hose, with shut-off nozzle or controlling nozzle to avoid water damage. For outside lines, 2½-inch and sometimes 3-inch hose is used, usually with 1⅛-inch or 1¼-inch

nozzles. There is an increasing tendency towards the use of deluge sets, turret nozzles and water towers for spreading fires, with nozzles 1½ to 2 inches in diameter, sometimes even larger. One of our engines is seldom expected to furnish more than two streams from 1⅛ or 1¼-inch nozzles, whereas the practice in some foreign countries is to run out from two to five lines from an engine of not more than half the capacity of an American engine. These streams are, of course, used inside and close to the fire where possible, and structural conditions and hazards tending to result in serious fires are comparatively rare; however, a comparison of statistics indicates that while the number of fires per thousand of population is very much less in Europe than in this country, the loss per fire in many foreign cities, most of those in Germany being notable exceptions, is as high or higher than in our own cities.

Salvage work has in the past been left largely to the insurance interests, but this, as well as fire extinguishment and fire prevention, is being taken up by some departments. Besides the steps taken to reduce water damage by the use of chemical streams and shut-off nozzles, companies should carry and spread covers to protect goods, and clean up after fires.

Fire Alarm Systems.

The fire alarm system has been properly called the right arm of the fire department, as the promptness and accuracy of its notification largely determine the extent of the fire. A brief description of the main features is therefore pertinent.

In 1851, the question of utilizing the inventions of Morse telegraphy for the sounding of fire alarms was taken up, and apparatus invented by which tower bells could be sounded from stations distributed throughout the city. The modern fire alarm system has been developed from this beginning. The boxes contain clockwork which actuates a figure-wheel and is connected by an electric circuit to headquarters or central office. Each box has its own number, which is transmitted through headquarters to the various fire stations and designates the locality of the fire. From headquarters, alarms are transmitted either manually or automatically. In the former case, the box number is received by operators at headquarters and sent out over circuits, distinct from those containing boxes, either by a Morse key or a special transmitter. This type of system is best suited to large cities where two fires are apt to occur at about the same time, or where a number of boxes may be pulled for one fire; accuracy and speed depend to a very great extent upon the operator. In the automatic system, alarms are transmitted, at headquarters, by a repeater which receives an alarm from a box on one circuit and sends it over the other box circuits, and in some cases over special circuits, to the various fire stations without manual intervention or assistance. This type of system is for use in the smaller places, where cost of maintenance is an important factor and simultaneous alarms are infrequent.

Every Alarm Must be Recorded.

Proper design and maintenance require that every box alarm will be

received at headquarters and recorded automatically. It is of more or less common occurrence for a number of boxes to be pulled for the same fire, or for alarms for two or more fires to come in simultaneously, either over the same or separate circuits; this condition, in connection with the above requirement, calls for rather complicated central office equipment, and for boxes of the type known as non-interfering and successive.

Fire alarm telegraphy is a specialized subject with which comparatively few engineers are familiar, but one which is at the present time receiving a much greater degree of attention than it has in the past, especially in a number of the larger cities where the increase of complications with growth has required special study.

The Automatic Sprinkler as a Conflagration Stop.

By Albert Blauvelt, (Member N. F. P. A.)

The city of Boston in 1893 had a fire which was absolutely beyond the control of the fire department until checked by a sprinklered building, known as the Brown-Durell Building, a very large brick building which stood directly in the path of the brunt of the hot blast. The heat opened a large number of sprinklers and the hot blast was sufficiently absorbed by the volume of spray and that hot blast did not emerge on the lee side of the building and the city was saved. Another sprinklered building, the Kilgour, is also credited by good judges as having been of similar service in Toronto in 1904. The spray must be deep, must be backed by a large water supply and must be inside, not on the outside, of the building, because outside spray blows out of place and away in a wind such as always exists at a time of conflagration.

The fire in the roof of the old State House about 1832.
From a fire department certificate of the City of Boston, issued February 15, 1833.

Water Service Emergency Gangs.

By George H. Finneran.

General Foreman, Water Service, Boston.

The necessity for a water-service emergency gang of high moral, mental and physical standards in these days of high-pressure service and increased number of pipes, is evident to all waterworks men. The old causes of trouble — defective material, water ram and frost — have been supplemented by breaking of hydrants by carelessly driven automobiles, the increased number of hydrants projecting above the surface, and other causes attributed to subways, underground wires, pneumatic tubes, deeper buildings and other modern constructions.

The men of the emergency gang should be selected carefully. They must know the locations of the city's pipe lines so thoroughly that they can tell the exact location of any part of the system, its connection with the main pipe, and the location of the controlling gates. Methods of making quick or temporary repairs must also be a part of the knowledge they should have ready for instant application.

Equipment Affects Efficiency of Gang.

Proper equipment is the next consideration in securing the maximum efficiency from the emergency men. Heavy wrenches are needed with which to operate large gate valves, and lighter ones should be on hand for the smaller valves. Wrenches for corporation and curb cocks, hydrants and air valves should also be carried. Calking tools, hammers, crowbars, picks, shovels, brooms, hand pumps, spoons to remove dirt from gate boxes, and lanterns of different kinds should also be carried. A gasoline or kerosene torch to thaw out gate covers, a force pump, connection pieces, rubber boots, and a gate finder will be found handy accessories. A useful piece of equipment is a powerful jack to help in extricating the heavily loaded wagon or auto from a soft spot in the road. Plans showing the pipe system should also be carried with the emergency outfit and kept up-to-date.

Speedy transportation is another important factor in giving the best emergency repair service. This requirement is best met by the automobile in the form of a truck. With seats extending lengthwise storage space is available underneath, and a rear entrance can be provided easily.

Boston's Emergency System.

The emergency gang as operated in Boston is divided into three 8-hour shifts, each in charge of a leader. The day shift consists of four men, including the leader. Each of the night shifts consists of six men. There is also a man on duty in the office during each of the night shifts and on Sundays and holidays. He takes all messages and notifications and directs the emergency gang to the point of trouble.

Owing to the 8-hour law men cannot be worked more than six days a week. It is therefore necessary for each man to suspend his work one day in seven. This is so arranged that there will be but one man off on each shift each day. This practice of laying the men off one day in seven reduces the number of men available by one the greater part of the week. To offset this, one more man is added to each shift to serve as a substitute during the absence of a regular man on his night off or during his vacation. Some risk is attached to laying off the leader, as he is the most capable man, and the most serious break is likely to occur the night he is off.

Most of the calls could be attended to by one or two men, but it is necessary to have a sufficient number of men on hand at all times. During the day it is always possible to get assistance in handling large gates, but at night it is practically impossible. Therefore, in the event of a break in the lines of large diameter with water flowing at a great velocity through the valves, it is necessary to have at least five men to close the 36-inch gates. Arrangements are made so that in the event of a very difficult shutdown, where several large gates have to be operated against a strong head, other men on duty in the stable and fire room may be called out to assist.

Method of Procedure.

When the emergency car is dispatched to answer a call, one man is left behind at headquarters unless the notification makes it plain that a serious job is at hand. The man at the telephone can usually judge the seriousness of the trouble by the number and rapidity of the telephone calls. Where there is a break of large dimensions, the average citizen considers it his duty to inform the water, police or fire department, whichever in his judgment is the proper one, and the result is an avalanche of notifications directed to the water department. As a rule, there is no mistaking real trouble by this sign alone.

The man left behind at emergency headquarters is available in the event of another call coming in after the car has left in response to the first call. Sometimes the gang is sent out on a trivial matter and a few minutes after its departure notice is received of a serious leak. The man at quarters responds with a horse and light wagon and, if possible, controls the situation himself. If it is beyond his ability, he telephones to the office. In the meantime the office man has been getting in touch with the emergency car and has in all probability directed it to the scene of the second leak by telephone. The occupant of a house or store in the vicinity where the car was called is asked to summon one of the men to the telephone. If this is not possible the men are reached through the police.

It is a rule of the emergency service that as soon as practicable after arriving on a job the man in charge of the gang is to telephone the office his whereabouts, and the nature of the trouble, and receive instructions as to his next move. In this way time and travel are saved by moving the car from job to job, rather than have it return to quarters after each one.

Render Aid at Large Fires.

It has been customary, during the last few years, to have the emergency gang report at all large fires, the object being to render any aid that it can in connection with the water supply. In the case of a very large fire, where the supply is insufficient, it may be possible to reinforce it by opening division gates that are usually kept closed to separate high and low pressure systems. If the fire is in the vicinity of the boundary line of the city, gates may be opened admitting the supply from some adjacent town or city.

The well-organized and properly conducted emergency service in a water department of any large city of to-day is a valuable asset. Beyond its efficiency in its own special line, whereby it saves money by minimizing property losses and public inconvenience, it serves as a stimulant to the department of which it is a part to keep its system up to a high standard of efficiency. The emergency gang in the course of its regular work is constantly uncovering weak spots in the system, and thereby aiding in the general work of the water department.

Sprinkler Leakage.*

By Albert Blauvelt (Member N. F. P. A.)

It seems to me, speaking from the underwriter's view point, that sprinkler leakage has not as yet been reduced to a commercial average. It is not a matter in which you can turn to an index schedule and write an intelligent letter to an agent as to just what you can do without having seen the risk, and simply and only because the risk may be rated. This is not in any sense a disparagement of the existing system of rating of sprinkler leakage, at least as conducted by Mr. Parker, who is handling the subject very intelligently.

The principal reason why sprinkler leakage seems to me peculiarly far away from the commercial average lies in the fact that the policy form is ordinarily written upon an assumption of ten per cent to value, and unfortunately that value is indefinite.

I do not believe that there is any possible method of contriving a schedule for sprinkler leakage, and have such schedule actually based against the particular and peculiar part of the value against which sprinkler leakage liability is incurred. The property owner ordinarily announces the value from some notion of his own or perhaps takes his fire insurance as a basis, and says that he will accept a policy form covering ten per cent thereof.

Now we know that fire insurance is not in any way a close measure of the burnable value of a risk. Furthermore, we also know that susceptibility to sprinkler leakage may mean a large part of the burnable values of a risk, or it may mean but a small part of the same. Therefore, in practice, a sprinkler leakage policy intended to represent ten per cent of the water damageable values in a given establishment is apt, despite your reasonable precautions, to be quite inaccurate, and right here it seems to me is an opportunity for error which stands in the way of reducing sprinkler leakage to definite commercial statistics and to a constant rating basis.

I am not sure I make myself clear, and perhaps can illustrate the idea somewhat by referring to the physical difference of arrangement of sprinkler leakage values in different establishments of equal value. In one the building may be one of small area and tall, with leaky floors, so that it would be a practical impossibility for much sprinkler damage to occur on an upper floor without involving a large part of the risk. On the other hand, should the same hazards and the same occupancy be spread out on one floor, then it is obvious that the water damageable

*From address before the Underwriters' Uniformity Association.

values are those which lie within the radius of the particular sprinkler or pipe which may burst or break, and that if the floor area be large the chance of the water damage liability running to ten per cent is remote.

On the other hand, in the instance of manufacturing business, such as is written by the Eastern and Western Factory Insurance Associations, and the New England Mutuals, where the occupancy is largely manufacturing and very thoroughly spread out and very frequently a large part of the burnable values are not subject to water damage, the sprinkler leakage liability seldom approaches anything like ten per cent of the gross water damageable values of the plant, and of course is a still lesser proportion of the burnable values.

It seems to me you have such an enormous range of variance of proportion of the face of your policy form as compared to the actual sprinkler leakage liability in different risks, depending upon the physical arrangement as well as the hazard and occupancy, that it behooves those who are writing sprinkler leakage in the open market to stick to one rule. I earnestly counsel you to stick to one constant policy form and not attempt to trade on it. The years will be long enough and the difficulties will be great enough under the best possible practices before any commercial average of sprinkler leakage results can become developed. I emphasize these remarks particularly because some of the men I have talked to appear to be deceived by the comparative simplicity of sprinkler leakage as applied to isolated manufacturing risks and with liability limited to that caused by the sprinkler head alone.

When general sprinkler leakage underwriting is undertaken to include mercantiles and to include water damage in all classes of risks, whether from large or small causes, the conditions are indeed complex.

Difficulties and Types of Alarms.

Taking up the physical conditions applying to sprinkler leakage in field experience, the first question in order seems to be how to stop flow of water as soon as possible after a break has taken place. In this connection the sprinkler alarm is the main reliance to give warning and call help to check needless flow of water.

Speaking for the inspection department of the Western Factory Insurance Association in attempting to serve our members on upwards of 4,000 agency risks, scattered over the central west, it has been a matter of disappointment, to the speaker at least, that we should not have been able to give more definite advices on the subject of alarms. To make some explanation on this point, it appears to us that the alarms in this field, in the mercantile risks particularly, have almost without exception been imperfectly installed. The result of this is that the inspection office, which does not have full jurisdiction and makes inspections after the original installation of the equipment, finds itself without means of properly testing alarms.

It is true that many alarms have electric switches with which to test whether the battery or other current is in service to ring the gong. Testing

the gong, however, does not test the alarm, and the alarm can be tested but in one manner, and that is by drawing water from the sprinkler system itself precisely as if a sprinkler head had opened.

I am aware that some inspection offices attempt to do this by opening slightly the main drain of the sprinkler system, but when you consider that these main drains are two inches and that a two-inch valve does not have to be opened more than about the thickness of a visiting card in order to pass water to represent the discharge of one sprinkler, the speaker feels justified in saying that any tests made at the main drain valve will usually draw water equivalent to the discharge of several sprinklers.

Now, on sprinkler leakage the imperative thing is to have an alarm which is sensitive to the play of one sprinkler, and speaking from an extensive field experience, the speaker can assure you that the efficiency of the sprinkler alarm as shown by the National Fire Protection Association records is not based on sprinkler leakage cases, but based on cases of fire of sufficient consequence to attract attention and develop a detailed report including the action of the sprinkler alarm, and frequently opening more than one sprinkler.

Certain types of alarm valves will operate with one sprinkler quite as readily as with several sprinklers. Other types of alarm valves, while they will operate nicely at a flow representing several sprinklers, will not operate at all under the average field condition in response to a flow representing but one sprinkler.

All that is necessary is to have some means of drawing the water directly from the sprinkler system, in the form of a ½-inch jet if taken from the top of the system or a ⅜-inch jet as the equivalent of the jet first named if more convenient to take same off in the basement or at the bottom of the sprinkler system, where the pressure is greatest.

The foregoing remarks on alarms apply particularly to the ordinary electric alarm. Our inspectors report a great many failures of water flow alarms, due to corrosion, mud, ice, snow, wasps' nests, birds' nests, bad installation and lack of attention.

The alarm which thus far in this field gives the most satisfactory service is that which is a part of the supervisory system.

I am a skeptic as to the value of the supervisory system and believe that it is not worth what it costs, but such belief refers to the gate and tank devices, and does not apply to the water flow alarm considered as a separate feature. It is only fair to state that the general results of this particular alarm are quite good.

Losses from Heads, from Piping, from Supplies.

Taking up the relative importance of cases of water damage, it appears that there is a very considerable difference of opinion as to the relative importance of the sprinkler head itself as compared to the piping, and as compared to those severe disasters which come from the collapse of gravity tanks or rupture of supply mains.

So far as the speaker can gather from men of direct commercial

experience, the indications are that the sprinkler head itself is the cause of about 50 per cent of the losses; and the troubles connected with large or small piping, including freeze-ups, produce somewhere around 30 per cent, and that the remaining 20 per cent arise from the occasional but very severe losses which occur in connection with the collapse of tanks or the rupture of a header or equivalent full volume of water supply.

The commercial statistics do not appear to be far enough along to attach much importance to the approximation just mentioned, yet, as stated, such is the average sense of experience thus far.

The Sprinkler Head.

As to the design of sprinkler heads, the writer does not think that there is much which can be studied with any special profit.

The sprinklers of the present day are the same in principle as those which have been used for a quarter of a century; all of them are snap-open or spring-tension devices, and the spring-tension throws a constant strain upon the sprinkler link or solder joint without reference to the water pressure exerted on the sprinkler.

The speaker had quite a conference with the Underwriters' Laboratories, and finds that the same view is held there, that the design or difference of design between sprinklers is not of great importance.

The shop practice in the making of automatic sprinklers is of the highest importance as affecting the probability of sprinkler leakage, and the Underwriters' Laboratories expect to control this all-important matter of the shop practice more fully for the future by reason of having shop inspectors stationed in the various manufacturing plants where the sprinklers are produced.

The solder joint appears to be the sensitive point. Those who have taken nippers and pulled sprinklers apart have probably observed that in the production of automatic sprinklers it is impossible to get the solder joints uniform. The design of the automatic sprinklers, as earlier remarked, has been quite satisfactory for more than twenty years, but when it comes to executing the design in the shop to the extent of making up sprinkler joints by hundreds of thousands, it does not seem possible to do this soldering with the perfection desired.

The conscientious manufacturers do this work wonderfully well, and a further excellence is expected to be extended to the sprinkler shops in general. Even with perfect solder joints, however, there would not be a cessation of sprinkler leakage trouble from the individual sprinkler head, because the heads are more or less abused, bent and injured in shipping and handling. The sprinkler workmen occasionally let a head fall from off a step-ladder to the floor and cannot be relied upon to reject the sprinkler if the workman thinks it looks good enough.

Freezing of Pipes and Sprinklers.

The effect of ice in the pipes is certain to burst certain makes of sprinklers and is apt to make any sprinkler leaky.

If, however, a sprinkler should neither burst nor be made leaky by freezing, it is the writer's opinion it is not safe to trust it after exposure to the ice pressure.

The reason for this is rather technical and possibly not well taken, but it has been the speaker's observation that after a solder joint has once been severely strained, although it may have suffered no apparent injury, yet it is only a question of time before the solder joint will let go as a delayed after-effect.

Some offices believe that it is a point of merit for a sprinkler to be strong enough to resist ice. The speaker thinks not, on the grounds that when ice forms in pipes something must burst, and as above explained, the sprinkler even if not apparently injured, will have to be replaced anyway, and if the heads do not burst the lack of vent will compel the pipe or fitting to burst. Doubtless no rule and no uniform result can be reached, but as a choice of evils it seems better that the sprinklers should go rather than the pipe. The flow of water may be greater or less in different cases, but in any case the sprinklers are easier and cheaper to replace than the piping, and the interruption of sprinkler service as affecting the fire insurance would be lessened.

Turning from the sprinklers to the piping, the indications are that the principal troubles in connection with piping also arise from freezing, and from this we have the question as to whether the wet pipe system is more or less advantageous than the dry pipe system.

Speaking from the compilation of field results of inspections in this territory, it would seem fair to say that while the dry pipe system has several inherent disadvantages, yet with the wet pipe system, the failures of heating apparatus and the difficulty of judging in advance how much heat is required, are such as to make the choice very much in the nature of a standoff.

The speaker does not believe that any man can show any commercial tabulation worthy of the name which will prove that the wet pipe system is preferable to the dry pipe system, or vice versa, either from a sprinkler leakage viewpoint or as a matter of fire underwriting.

The only practical suggestion that the speaker can think of, to reduce the sprinkler leakage troubles which arise from freezing, is that those inspectors who make a specialty of sprinkler leakage should do less guessing as to whether the wet system equipments are or are not liable to freeze.

The assured is also in a position of guessing, because we must believe that the assured would rather have the pipes kept warm than permit them to freeze up, and afterward pay for the repairs. About the easiest way to get some idea in advance as to whether a drop of temperature outside is likely to cause the temperature to go below freezing inside, is to gauge this in advance by putting up a recording thermometer. By this is not meant one of the elaborate thermometers with clock works, but the small and inexpensive type which has a little wire within the tube so arranged as to mark the point of minimum temperature, making it possible on any reading to know how low the thermometer has gone since placed in position.

If, for example, the thermometer shows any given space to have gone as low as 40 degrees or 45 degrees in ordinary cold weather, it may be taken as certain that a cold snap will drop the same locality below 32 degrees.

In this manner a definite showing can sometimes be made, and owners of wet pipe equipments can be persuaded to go further in the way of increasing the heating apparatus or of making the heating apparatus more constant and with a better circulation.

Prohibitions.

With regard to that part of sprinkler leakage losses which occur in the form of very severe disasters, wooden tanks having flat hoops and located near buildings; or in cases of heavy vertical pipes supported by an elbow with no footing under the elbow; or large quantities of sprinkler heads placed pendant with no protection cages; or a blind attic on a wet system with no circulation whatever provided to convey heat into the attic, or in any case of severe tensile stress or direct water hammer upon an unsupported lead joint; or a gravity tank on a wooden structure placed above a building and with no accommodation to prevent the main pipe from breaking should the tank settle; or a risk having no supervisory, no watchman and no method of testing the alarm by actual flow of water as earlier described in this paper; in these and similar cases you have an open and glaring condition and one for which in the writer's estimation the underwriter cannot be compensated by any obtainable rate.

Discussion.

MR. DAVIS: I would like to ask if any thought has been given to the advisability of placing a maximum and a minimum temperature device that may be attached to supervisory equipment in those risks where a supervisory system is installed. We have attics that might be heated and these risks have supervisory systems. Could they not have a temperature attachment located in those attics that would notify the central station in case the temperature got down in the vicinity of freezing?

MR. BLAUVELT: There is no question but that can be done. My objection to the supervisory system is commercial, purely commercial. The supervisory service is a very nice thing for the underwriter, when it does not cost more money than the premium necessary to carry the business. The water flow alarm is worth a good deal of money in and of itself alone. I think that detail of it is worth its proportion of the supervisory cost, but when you extend the supervisory to the general details of the equipment I think then it becomes in all wholly a commercial thing. My suggestion, in recommending the use of a maximum and minimum thermometer was one which I hoped might extend the efficiency of the inspection service of the day on this specialty and keep within the commercial bounds. We cannot always do many things that we would like to do because we cannot do it out of the income that the low rates of the present day on these specialties afford.

MR. DANA: There are two points in Mr. Blauvelt's remarks I would like to refer to. First is the efficiency of the alarm valve. Our experience in the East has been that the alarm valve is a pretty reliable device, and if you will look at the annual statistics of the N. F. P. A. you will find it is more reliable than either thermostats or watchmen. The Association's statistics show about 77 per cent failures in the case of watchmen and from 12 to 13 per cent in the case of alarm valves. I will admit that there are a great many alarm valves that are not properly installed, a great many that give false

alarms and a great many that are found out of order during inspection, but the fact is in the case of fire they must work. The testing is the key to the situation and it is the key to satisfaction. I don't believe there are many equipments where you can't make that test. Of course, there is always a draw off pipe on any system, and if there is no test pipe you can use the two-inch draw off pipe. You must know how to use it. You must not open it wide, you must open it to provide a water flow the equivalent of one sprinkler, as near as you can. I don't think there are many alarm valves that will not work under normal conditions.

The other point I had in mind was the difference in sprinkler heads in regard to sprinkler leakage. There have been some tests made in Boston lately to determine the difference in the heads in regard to damage from freezing. I don't know how important a fact that is in actual sprinkler leakage loss. We have a great many losses from freezing, but I imagine in the future that this detail may become of some importance, and these tests would seem to show there is a very marked difference in the various types of heads as to their ability to resist freezing. Some types will burst at the first freezing and blow to pieces, open up wide; in others there is enough elasticity in them and they will spread and may leak some, but will not open, and it seems to me that is a factor that should be investigated further, and may be of some importance some day.

The tests which I referred to seemed to show that these sprinklers which did not open wide in cases of freezing would leak slightly after being subjected to freezing, so I think Mr. Blauvelt's suggestion that they might be left in the system would not generally hold. They usually leak enough so that they will have to be taken off.

MR. BLAUVELT: Was that invariably the case?

MR. DANA: I think it was invariably the case. I can't tell you definitely. Another point is that the solder joints never gave way. The freezing does not seem to be a strain on the solder joint, as might be expected. That is, the strain is taken largely by other parts of the structure, so that the solder joint seems to be the strongest part. It does not appear that the solder joint is very much weakened by the freezing.

MR. BLAUVELT: I don't know whether you got my point precisely, Mr. Dana. The solder joint will not give way, but the fact that you have thrown a strain on it starts a deteriorating action and some day under continual strain that solder joint will crawl. In other words, if you have a solder joint which is all right, that solder joint if over strained severely, or ruptured a little, even if wholly imperceptible to the eye, will, if you continue it along under the usual strain, eventually let go.

MR. DANA: I think the fact is that the sprinklers all leak somewhat after the freezing.

Asphalt Plants.

Character of Asphalt — Methods of Procuring and Preparing — Uses — Fire Hazards.

By Charles C. Dominge (Member N. F. P. A.).

At Vandalia, Ill., on March 11, 1913, a modern Paul Revere distinguished himself by riding at breakneck speed down a steep hill, warning the villagers below of their imminent peril from a stream of burning asphalt. A tank of asphalt roofing compound had been exploded by the heat from a burning rag warehouse located nearby, and the burning mixture, flowing on the water in the ditches, brought destruction to buildings fully a thousand feet away.

Historical.

The Bible tells us that the basket in which Moses was left in the bulrushes was "pitched without," and no doubt it was asphalt, as the first known deposit of asphalt was found in Egypt. Later on, and through centuries the ancients used the same pitch for covering their embalmed dead and many mummies have been found in recent years and are still being found, where the asphalt coating is distinguishable. There is an authentic case on record of the discovery of a hull of an ancient shipwrecked vessel that had lain on the bottom of the sea for ages, and on inspection showed that its bottom was coated with asphalt, which remained in a fair state of preservation in places where it was buried deep in the sand and thus protected from abrasion.

What Asphalt Is.

Asphalt is the name given to a bituminous substance of solid consistence. It is known under many names, such as Native Pitch, Mineral Pitch, Jews Pitch, Dead Sea Bitumen, Compact Bitumen and Maltha.

It probably owes its origin to vegetable matter which has been subjected to a slow process of decomposition or decay, resulting in the production of a bituminous coal, from which, by volcanic agency, the asphalt has been distilled and diffused over the neighboring district.

Some people believe that nature in the formative period of the earth made these asphalt deposits by the fiery destruction of both vegetable and mineral oils. The non-combustible bitumen of the burned oil flowed into the crevices of the earth, from whence we now extract it.

Asphalt is also taken from the earth in a liquid state by pumping to the surface from holes called wells. This product seeks the lower level because of its liquid state. It is said to contain between five and

thirty per cent of naphtha and it is therefore more dangerous than ordinary asphalt.

Where Asphalt is Found.

The largest deposit of asphalt in the world is located at Pitch Lake on the Island of Trinidad, where it fills a basin to a depth of nearly 100 feet. Other deposits are found at San Timolis, Venezuela; Mexico; Santa Barbara County, California; Central Kentucky; Seyssel, France; Val de Travers, Switzerland; and Ragusa, Italy. Recent reports show that asphalt in a practically pure state has been discovered in large quantities on the Island of Leyte in the Philippines, and this product bids fair to become an important natural product of the island, says the Manila *Daily Bulletin.*

Various Uses of Asphalt.

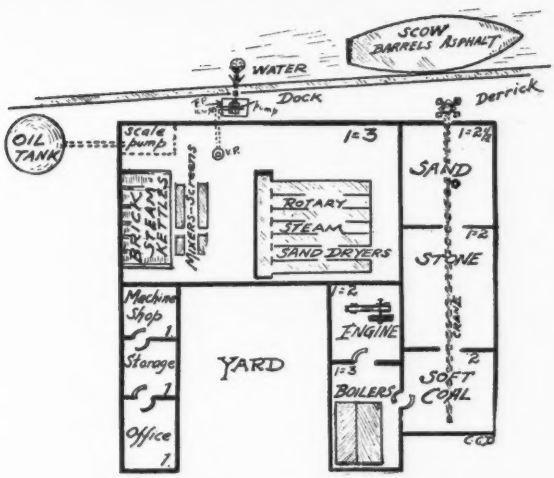
Asphalt has many uses, the product from Trinidad is largely used for ships' bottoms, and is reputed to kill the teredo or borer, which proves so very destructive to the wood of ships in tropical regions. It is also used for paving purposes, roofing compounds, painting (thinned with petroleum distillates), and the material recently found in the Philippines is said to be suitable for the finest uses, such as Japanese lacquer work, etc. Asphalt in a heated condition is used for saturating timber which is intended for piles to be used in the construction of breakwaters, river-bridges, and other situations where the combined action of the air, water and minute animals would soon render ordinary wood rotten and useless.

Construction of Buildings.

As a general rule the type of buildings used for the manufacture of asphalt products are of light frame construction, sorely in need of repairs, located in a remote place with unpaved streets and little or no fire protection. In the mind of the writer if the plant is located in an isolated section, (provided the protection and roads are all right), it is better; as this class should never be located in a "built up" or growing section, because it is a nuisance and thereby likely to be destroyed by some one for revenge. The new plants now being erected are absolutely fire-resistive in all details (either reinforced concrete or steel framing well insulated) with the floor openings in terra cotta or concrete shafts, and fire doors at the openings and all exterior openings protected by wired glass in metal frames.

Manufacture of Paving Asphalt.

Refined asphalt is brought in wood barrels or metal drums (no refining done on the premises). The asphalt is then placed in direct, coal-heated kettles (brick set, open iron) or brick set, steam-heated kettles. The flux (a heavy residuum mineral oil) amounting to about 15 per cent is then added (see under "Refining" for a description of this oil). This mass is allowed to cook at a temperature of from 250 degrees to 350 degrees Fahrenheit for about four hours. The oil and asphalt thoroughly mix during this time, the mixing being induced by the heat in conjunction with a compressed air agitation, the air being released at the bottom of the kettle.



A MODEL ASPHALT PLANT.

Fire resisting construction throughout, with cut-off fire sections. All-steam process, electric lighting, oil tank safeguarded and standpipe system. No refining in this plant.

After the cooking the heated mixture is conveyed by buckets into mixers, where cracked stone and sand from steam-heated rotary dryers are added in producing the first or binder course, the percentage generally being about 10 per cent asphalt to about 90 per cent sand and stone. The finishing coat or layer is produced by mixing 9 to 12 per cent asphalt, 5 per cent Portland cement, and about 85 per cent sand. The kettles used resemble large direct fire, brick set bake ovens, having an eight-inch segmental brick shield over the fire-box with an air space of from sixteen inches to twenty-five inches between the shield and bottom of the kettles. The oil or "flux" which is usually located in an elevated tank some distance away, is conveyed through a pipe and pumped to the kettles.

Refining.

Although this part of the business is seldom carried on in asphalt plants of today, the experienced inspector on visiting a plant will at once ascertain if there is any refining. Usually this work is done in an outlying section, perhaps miles away from the plant proper and the refined asphalt is shipped to the various plants in drums or barrels. The process, briefly described, is as follows: Crude petroleum having an asphalt base is brought by ships from Trinidad and pumped into tanks. It is then drawn from the tanks and pumped into coal-fired or steam-heated stills. Vapors from these stills are condensed in steel condensers and cooled by salt water. The flash point is said to be from 120 to 150 degrees Fahrenheit. After a distillate or what may be termed burning oil (flash 300 to 350 degrees Fahrenheit) is distilled off, the residue with a flash point of from 300 to

450 degrees Fahrenheit, is left at the bottom. This residuum or flux is a black tarry oil just a little lighter than water. It is this residue which we find in the asphalt plants in our vicinity being used as the "flux." Oil of turpentine is sometimes used as a solvent.

Von Schwartz's Fire and Explosion Risks says:

"Natural asphalt has the specific gravity 1.100–1.200, melts at 212 degrees Fahrenheit, forms an almost coal-black mass, and contains volatile oils furnishing inflammable vapors exploding on admixture with air. To eliminate these substances the asphalt has to be warmed to 340 degrees to 455 degrees Fahrenheit until all the volatile oils have been driven off. This operation is dangerous, but the resulting asphalt is far safer than before. Well purified asphalt should not lose more than two per cent in weight when heated to 437 degrees Fahrenheit for six hours, any greater loss indicating imperfect purification and correspondingly increased danger. Most of the agents employed for dissolving asphalt are dangerous (benzol, petroleum, carbon disulphide and ether, though the latter is merely a partial solvent), and hence the resulting solutions are dangerous to handle. A special warning must be uttered with regard to the inflammability and consequent ignitibility of asphalt when applied to any surface. Though inflammable, asphalt does not burn with readiness; nevertheless, burning asphalt forms a very dangerous disseminator of flame, the more so because it is difficult to extinguish. All articles that have been coated with asphalt, more particularly as a protection against moisture or decay, thereby acquire a high fire risk and this work must not be performed near any open fire or lights."

The Oil Storage Tanks.

The writer a short time ago witnessed the demonstration of a recently developed automatic chemical device for extinguishing fires in oil tanks.

A large tank was nearly filled with water, above which was a layer of Mexican crude oil five inches deep, and above this two buckets of gasoline were suspended to facilitate ignition. The gasoline was ignited by an electric spark and the oil began to blaze and flames were shooting up about ten feet, when from four upright sheet iron tubes at the sides of the tank, streams of a white fluid poured out and in nine seconds the flames had disappeared. To obtain this result chemicals were placed in the four upright tubes, then sulphuric acid was added to them, transforming the contents into a foamy substance of which the principal ingredient is carbon dioxide (a gas that is deadly to flame).

At the top of each tube is suspended a receptacle containing sulphuric acid and held in place by a wire which extends across the tank and is fastened to similar wires from the other tubes by an easily melted metal. When the oil in the tanks takes fire the flames melt the metal wire holder, releasing the sulphuric acid receptacles and starting the chemical action.

Provision should be made so that in case of fire the oil can be drawn off to another tank away from the fire zone.

The Fire Hazard

consists almost entirely of lightning striking the oil storage tanks. For this reason lightning rods should not be attached to tanks, because they are apt to attract the lightning, and as there are more or less explosive vapors at the top of the tanks, the flash when the lightning strikes the rod is likely to ignite the vapors, which in turn would cause the oil to burn.

The open flame is also a serious hazard, but in up-to-date plants no fear is occasioned from this quarter as all stills, heaters or dryers, kettle furnaces, etc., are heated by steam and the lighting is by electricity with vapor proof enclosures and with switches located on the outside of the plant proper. Old-fashioned plants still use the "direct fire" heated furnaces which have been the cause of most asphalt fires. One can easily see how the asphalt and oil mixture when boiling is liable to come in contact with the naked flame. Where open flames are still used the inspector should recommend a draw-off valve and a flanged shield, so that any overflow will not find its way to the flame.

Action of Fire.

Asphalt behaves in two different ways in the presence of fire:

1. Spreading flame when applied as a thin coating on objects.
2. Preventing the transmission of heat when as a compact mass in walls and floors.

Spontaneous Combustion.

Von Schwartz says the practice of adding oil of turpentine to asphalt, before or after melting same, may easily result in spontaneous ignition.

Fire Protection.

Although the insurance engineer fairly dotes on automatic sprinklers, this is "one class" in which they are not recommended by most experts. Plenty of sand and chemicals would give a better account of themselves, in conjunction with a standpipe system to put out the incipient fire among the woodwork. All storage tanks should have a permanent electrical ground, so that in case of being struck by lightning, this may prevent the ignition of the contents.

The Choice of Pumping Engines for Municipal Water Supply.*

By J. E. Craig.

Engineer, Board of Commissioners, Jacksonville, Florida.

Since water to the inhabitants of the various towns and cities is frequently furnished from a publicly owned water works system, the problem of deciding upon the best pumping equipment to be installed for delivering this water is often met. I regret to say that after some years of experience it is generally found by the young engineer that the controlling Boards of many city works insist on their own superior judgment to decide such matters, and keep the engineer as a ready "goat" on whom to heap the blame when very bad results are finally obtained. Again, there are some who may be so fortunate as to serve some of the few public officials who have the wisdom to leave the technical matters to the decision of the

*From "The Cornell Civil Engineer."

engineer chosen for that purpose. For the service in villages and the smaller towns where the regular domestic supply is from an elevated tank, the demand is for a pump to fill the tank at intervals and to furnish direct pressure for fire fighting purposes. If there is available a reliable source of cheap electric power, motor driven turbine pumps, or triplex plunger pumps are desirable, the latter driven through gears by electric motors. If such electric power is not available, triplex plunger pumps driven by gasoline or kerosene engines are due careful consideration. These machines are highly desirable for intermittent service as they deliver their full output at once when started, instead of requiring such time as is necessary to raise steam in a boiler for a steam driven pump. In addition to the great loss of heat from the boiler while the pump is not in actual operation, the notorious inefficiency of all small direct acting steam pumps almost eliminates this type, except when operated in connection with an electric lighting system which requires that steam be kept up most of the time anyway. In considering the service for towns which use from one to five million gallons a day there is more field for careful consideration of the actual conditions to be met. When the supply is taken from a river and first delivered to filter beds, there is nothing better than the turbine pump for this service, as a low and practically constant head is to be operated against. The turbine pump may be driven either by an electric motor or steam engine, as the local conditions demand. Where the source of supply is wells in which the water does not rise to the surface, the engineer may consider several methods. One is the direct acting deep well pump with the steam cylinder at the surface and the water piston near the elevation of the sources of water, actuated through a long vertical piston rod. One of the best examples of this system is at Memphis, Tenn. The Memphis supply is interesting because such a large city is supplied from a great many wells scattered for a considerable distance and flowing into a masonry tunnel which is nearly 100 feet below the surface of the ground and which discharges by gravity into a sump at the pumping station. The steam cylinders of the vertical pumping engines are in the engine room at the surface of the ground while the water cylinders are far below near the surface of the water. These engines have given excellent service. The pumps at Memphis are in a sump large enough to give ample access, even at the bottom, for attention and repairs to the water cylinders. In the rice fields of Louisiana and Texas a submerged vertical turbine pump in the bottom of the well, driven through a vertical shaft either with a belt or electric motor has found considerable favor. For a reliable method of raising water from a considerable depth probably there is nothing better than compressed air. The air lift leaves much to be desired in the matter of total efficiency, but its reliability of operation and durability offset this objection. The entire engine is in the pumping station. One compressor can raise water from one well or many and they may be scattered widely. When the available funds will provide a compressor with Corliss valve, steam cylinders, and condensors, and two stage compression, if the required pressure warrants this, very satisfactory operating efficiency is obtained.

In the choice of pumping engines for the smaller cities, which require between 1,000,000 and 4,000,000 gallons daily, there is a slightly wider range of equipment from which to make a choice to meet the conditions of the individual installation. In this class of pumping station twenty-four hour attention is usual. Most such cities operate an electric lighting system in connection with the pumping station, which requires that boilers be kept in operation constantly. Under this condition the choice lies between several arrangements with steam as the motive power. When the engines operating the generators are of high efficiency, ample capacity and in duplicate, electric motor driven pumps give excellent total efficiency. The higher steam efficiency obtainable from the steam engine often more than balances the loss in electrical equipment. Either turbine pumps, directly connected to electric motors, or triplex plunger pumps, motor driven through gears, are available. It is usually demanded of municipal service pumping engines that they deliver the normal domestic consumption, against about 50 pounds to the square inch, for more than 95 per cent of the time in operation, and yet be capable of furnishing this same output and considerably more for fire streams, at 125 pounds to the square inch, or more. This condition means the engine must operate 95 per cent of the time, at about 40 per cent load, or at times of fire at more than 100 per cent over-load, depending on whether the engine is designed for its rated service at domestic or at fire pressure. To meet these requirements two turbine pumps can be operated in series for fire pressure and either operated singly for domestic service. To have duplicate equipment, either set of which is capable of meeting any reasonable daily demand for both domestic and fire service, is absolutely essential for a first class water works pumping station. To meet this condition will require much idle equipment, or operation at small load factor, with turbine pumps. Triplex plunger pumps, motor driven, give good efficiency under domestic service pressure, and will deliver the same volume at double the pressure when required. They are reliable and worthy of careful consideration in this connection. For service of this character, duplex direct acting, tandem compound, or triple expansion, condensing pumping engines are probably the most used. Under favorable operating conditions a duty of 70,000,000 foot pounds per thousand pounds of steam may be approached. In the smaller stations of this class, one more expensive compound engine may be installed, which will do most of the work with reasonable efficiency, and one standard underwriters' steam fire pump, which will serve to aid in giving fire service and can furnish the domestic supply also when the more efficient engine must be stopped for repairs. In many of the stations delivering 5,000,000 gallons a day or more, vast sums of money are wasted, either through the operation of equipment unsuited to the conditions, or that would be inefficient under any conditions. Here it becomes possible to make interesting comparisons between present and final economy. Large pumping engines may be obtained that will give very high operating efficiency. Some in daily operation are giving a duty of about 200,000,000 foot pounds per 1,000 pounds of steam. These engines,

of course, represent considerable capital, and the problem before the engineer is to determine how large an investment the proposition will warrant. It is possible to purchase costly, high-duty engines and operate them under such conditions that the interest on the first cost of the engine is more than the saving effected by their higher efficiency in operation. For the smaller stations in this class the horizontal cross compound crank and fly-wheel type of condensing engine offers a satisfactory total efficiency; its first cost is much less than the vertical triple expansion, crank and fly-wheel type, and a duty of 125 to 150 million foot pounds can be obtained. In the larger stations using only engines of a daily capacity of 12,000,000 gallons or more, every factor, before any but the vertical triple expansion type of engine is chosen, should be considered, if the necessary money can be secured to install the more costly type. Data should be obtained as to the actual daily probable output during the term of service of the engine and the cost and efficiency of the two general types of machines. In the larger pumping stations, when the city also owns its electric lighting system, there is a possibility of securing considerable saving in the joint operation of the two stations by having a turbine pump designed to deliver at best efficiency the average domestic consumption so that it will be running practically constantly; this pump to be driven by a synchronous motor so designed and operated as to improve the power factor on the electric circuit. In the field of pumping machinery the engineer has considerable equipment from which to choose that which will give the best total efficiency under the conditions at hand. He may take the first which is offered and make some salesman happy. He may misjudge the future conditions, and even after faithful effort fail in securing the best efficiency — it is human to err. He may consider carefully, judge correctly and secure excellent results — and he may get the credit for it.

Refrigerating Machinery Explosions and Fires.

The two refrigerating machinery explosions reported in this issue of the QUARTERLY one of which resulted in loss of life and the complete wreck of a building, leads us to review for the benefit of our members notes and correspondence on this general subject furnished us recently by F. J. T. Stewart (Chairman, Executive Committee N. F. P. A.) in a special report made by him for our member the New York Board of Fire Underwriters.

An unusual number of explosions or ruptures in connection with refrigerating systems served to call special attention to the action of ammonia fumes when thus suddenly released from the customary pressure of 125 to 175 pounds. It appears that in most cases, explosions of varying intensities or at least fire resulted directly or indirectly from the presence of the released ammonia vapor. The commonly accepted explanation of such fires or explosions has been that they are due to the presence of oil in ammonia gas, the oil being used somewhat extensively for lubrication and sometimes for cooling compressors.

By way of accounting for explosions of ammonia vapor suddenly released from high pressure, when not attributable to the presence of lubricating oil, it has been suggested that decomposition of the ammonia might take place, especially in the presence of an intense heat such as that of an electric arc light, resulting in the liberation of hydrogen which forms an explosive mixture with air. It has also been suggested that certain impurities in the ammonia might increase the tendency to decomposition or explosion. In a number of the cases reported herein a definite explanation of just what caused the explosion of the ammonia vapor seems to be impossible, but the facts as nearly as can be ascertained are submitted.

The practice of testing refrigerating systems with air pressure is especially hazardous, unless all oil is thoroughly removed from the entire system and great care is taken to prevent overheating of the air while being compressed. The last explosion herein reported was due to this cause.

Manhattan Refrigerating Company, Horatio and West Streets, New York, Accident of April 26, 1915.

The refrigerating plant is located on the 1st floor of Section D and parts of the refrigerating machinery extend to the 2d and 3d floors. Parts of the 2d and 3d floors were also used as pipe fitting and repair shop, with open coal forge on 3d. The 4th,

5th and 6th floors were used for cold storage rooms. The boiler plant was in the basement.

About 1 p. m. a noise described as "a puff," emanating from the 2d floor, was heard by the engineer and other employees. The trouble was caused by the breakage in a pipe connection on 2d floor between the analyzer and the rectifier of an absorption type refrigerating system. Immediately afterward a considerable number of glass windows in the front wall of the building were blown out. According to information received, a mild explosion occurred about five minutes after the accident. The ammonia gas had spread rapidly and reached the open coal forge on the 3d floor, which may have caused this explosion. Apparently the rush of gas scattered the embers of the forge, which resulted in a fire in workmen's coats hanging nearby. The fire also scorched some temporary wooden shelving which had been erected in the vicinity. Two automatic sprinkler heads also opened at this location and apparently extinguished the fire, as no water was used by the Fire Department. The sprinklers are said to have operated about fifteen minutes. An employee working on the roof claims to have extinguished some fire around the woodwork in the court by means of a pail of water. There was some damage to the switchboard on the 1st floor, apparently caused by water discharged by the sprinklers or possibly by the ammonia.

It seems difficult to account for the mild explosion alleged to have occurred about five minutes after the accident. One theory advanced is that the fire in the forge exploded a mixture of ammonia gas containing various impurities; the explosion can hardly be attributed to oil in the ammonia, as this was an absorption system. The force of the explosion is supposed to have spread the embers from the forge and ignited the combustible material in the vicinity and this fire to have caused the two automatic sprinkler heads to operate.

H. C. Bohack & Co., Retail Groceries and Provisions, 102 Seventh Avenue, Brooklyn, Accident of April 23, 1915.

The refrigerating machine in this case was a 6-ton Brecht Compressor driven by belt from a 15 H. P. direct current electric motor, and was used for cooling meat boxes, etc., by the direct expansion of ammonia through coils therein. The cylinder was cooled by water jacket around the cylinder head. Oil was used only for lubrication. The machine was not operated continuously and it was the practice of one of the employees to take charge of the system. It was usually started every morning; an engineer being employed to give advice and occasionally special assistance when needed. At 10.30 a. m., after the machine had been in operation about two hours, the cylinder head blew off, with a violent explosion breaking nearby windows and blowing down a four-inch tile partition adjoining the machine. There was no fire or evidence of any explosion resulting from the gas after it was liberated. The room was lighted by incandescent electric lights. The only possibility for any spark was at the commutator of the direct current motor.

It is difficult to account for the blowing off of the cylinder head, other than as the result of some mechanical weakness, or the presence of liquid ammonia or oil in the cylinder. It is claimed that there had been no testing of the system with air, which is a dangerous practice. This is one of few cases where no fire or explosion seems to have resulted from the liberation of ammonia fumes, presumably mixed with lubricating oil. The lack of an open fire or spark may account for it.

Mayer Brewing Company, 3544-3562 Third Avenue, New York. Accidents of April 11 and April 21, 1915.

The refrigerating plant, which in this case served a brewery, consisted of a 55-ton Linde and a 110-ton Vilter Compressor, each driven by a Corliss engine. Each compressor had an individual oil separator but there was only one set of condenser coils, etc., so that only one machine could be operated at a time. The brewery was refrigerated

by brine circulation. The cylinders of the compressors were cooled by the "freezing back" method (utilizing the refrigerating effect in the returning ammonia).

There were two explosions within a few days of each other. The cylinder head of the Linde machine blew out at 7.25 a. m., April 11, 1915, and the cylinder head of the Vilter machine blew out at 5.30 a. m., April 21, 1915, a few hours after it had been started, both compressors having been out of operation during the intervening time between the two explosions.

The two compressors apparently failed due to mechanical weakness in the materials of which the piston rod and follower were made.

The failure of the Linde machine was due to the breaking of the piston rod at the base of the thread at the nut which holds the piston on the rod. The fracture was without signs of flaw or crystallization. The dislodged nut was caught between the piston and the cylinder head on the return stroke and knocked out the head. Probably the vapor consisting of ammonia and perhaps lubricating oil filled the room and was ignited from open gas lights, and an explosion resulted, causing considerable damage to the building and machinery.

Repairs were completed in about nine days, and the system tested out to 300 pounds air pressure. After the test was completed, the air was thoroughly pumped out of the system, leaving a vacuum of about twenty-five inches of mercury. The ammonia was then replaced and the system put into operation, using the Vilter Compressor. About fifteen hours later a break occurred in this compressor; in this case, however, it was not the piston rod which broke, but the follower plate of the piston. The cylinder head was knocked out and the escaping ammonia and oil was again ignited from the open gas lights which had not been removed after the first explosion. The second explosion deranged the entire refrigerating plant and was followed by fire which resulted in the destruction of practically all combustible parts of this building.

Both explosions were probably due to lubricating oil mixed with the ammonia gas when discharged into the refrigerating room. A number of theories have been advanced to account for the rupture of the reciprocating parts of the compressors. The usual stresses together with the cooling and heating which occurs in every stroke of the piston, may have gradually weakened the piston. At a previous overhauling, the nut on the end of the piston may have been screwed up unduly tight; the expansion of the piston due to heating, in addition to the working loads may have stressed the material beyond the elastic limit. The piston rods were lubricated by the usual oil seal, the oil being circulated by a small pump, the only lubrication of the cylinder being by the oil which escaped from this oil packing. It is possible that an excess of oil may have found its way into the crank end of the cylinder from this source and filled up the clearance space with an incompressible liquid which would account for the break.

Chas. Weisbecker, Groceries and Provisions Market, 267-269 West 124th Street, New York. Accident of August 31, 1914.

The refrigerating plant consisted of two De La Vergne Compressors, one of 40-ton and one of 25-ton capacity, supplying refrigeration by direct ammonia expansion system to the ice boxes in basement, 1st and 3d floors. The compressors were chain driven from 70 and 40 H. P. direct current electric motors. In these compressors oil is injected into cylinders for the purpose of lubrication and cooling. Shortly after midnight, when the engineer was putting new oil into the system, the oil reservoir, with glass sight openings connected to the piping, broke and ammonia gas escaped into the room to such an extent as to drive out the engineer. The arrangement was such that practically all the oil in the system would be blown out. There was no evidence of any fire or explosion accompanying the bursting of the glass reservoir. There was no exposed fire or light other than the possibility of a spark at the commutators of the electric motors. No explosion appears to have resulted immediately from the liberation of the ammonia vapor, but there was evidence of fire having occurred later. The place was untenable on account of the ammonia fumes for some time. When entered the appearance of the compressor room indicated that a mild explosion or burning of the

mixture of the ammonia gas and liberated oil had taken place at some time subsequent to the bursting of the gage glass. The only spark to account for this ignition would be that from the commutators of the motors. The paint on the walls of the room and on the motors was blistered and discolored, and in some places slightly charred. The layer of cotton over the pipe covering near one of the motors was also burned. Some glass in the partition enclosing the compressor room was broken and papers on the engineer's desk next to these broken sashes were found on fire. The insulation on some of the electric light wiring was burned, but the windings of the motors were uninjured. No damage was done outside of the compressor room, other than the burning of the papers on the engineer's desk.

Jacob Ruppert Brewery,
205-207 East 92d Street, New York.
Accident of June 28, 1912.

The explosion in the refrigerating plant was caused by the breakage of four by-pass valves of the water jacketed York cylinders on a 280-ton De La Vergne refrigerating machine operating under 100 to 125 pounds head of steam and delivering ammonia to receiver at about 180 pounds. Oil was used only for lubrication.

It is stated that the machine was working normally at time of accident, in which case the by-pass valves of cylinders would be closed. (These by-passes are used to draw ammonia vapor from the discharge pipe into the suction pipe when emptying the compressor).

The cause of the breakage is not easily accounted for, but may have been due to a large influx of liquid ammonia from suction side into compressor; though this irregularity is generally recognized in refrigerating plants, especially in large installations supplying a number of lines, and can usually be adjusted without accident.

Three to five minutes elapsed between the breakage of these valves and the explosion, the latter being due to the ignition of vaporized oil in the escaping ammonia gas, or by the decomposition of the ammonia gas liberating hydrogen which would form an explosive mixture with air.

It is possible that the unenclosed arc lights in the vicinity caused the decomposition of the ammonia; in any event, it would appear that the arcs ignited an explosive mixture, however formed.

Part of the electrical apparatus on the switchboard was somewhat damaged and badly discolored. Some material in different parts of the room in the line of the explosion was burned, notably burlap behind the switchboard and a coat hanging seven feet distant. The damage to machinery was comparatively slight. There was practically no damage to the structure except that some glass and other fragile material in this building and elsewhere in the vicinity were shattered by the explosion.

Schwartzchild & Sulzberger Company,
First Avenue and 45th Street, New York.
Accident of March, 1901.

This explosion occurred in an oil separator in the discharge line from a 200-ton Vilter ice machine. This separator was constructed of extra heavy pipe, with cast steel caps at the ends, with screw joints, soldered at the ends. It was about twelve inches in diameter and six feet tall and was supported on a cast iron stand. A draw-off valve was provided at the bottom for removing the oil.

Previous to the explosion the compressor had been overhauled. When this was completed the engineer was instructed to clean the oil out of the separator. He claimed he did this, but the oil on the walls after the explosion seemed to indicate that this was not done, although this oil might have been blown out of the rest of the system. They then started to test the system with air pressure. The pressure had been built up to 250 pounds when the separator exploded with great violence seriously injuring a number of employees.

There seems little doubt that the separator or the system contained a considerable amount of oil and that this oil in contact with air formed a combustible or explosive mixture, which was ignited by the overheated air discharged from the compressor. This danger is always imminent when air is compressed in such systems, if any oil is present.

Mr. Robert D. Kohn, architect, past-president of the N. F. P. A., brought this report to the attention of engineers who have made valuable contributions in connection with the fire and explosion hazards of ammonia refrigerating systems.

The following letters from Mr. Frank L. Fairbanks, Chief Engineer, Quincy Market Cold Storage & Warehouse Company, Boston, contain information of particular value.

Briefly stated, Mr. Fairbanks' contentions are:

1st, That the danger of explosion due to the liberation of free hydrogen resulting from the decomposition of ammonia at high temperature must be taken into account in case of a break and is not an extremely remote hazard. The first accident covered in our report and dealing with an absorption type refrigeration system was probably due to this cause.

2d, The liberation of hydrogen is accelerated when zinc is in contact with ammonia at high temperatures.

Mr. Fairbank's letters follow:

(FIRST LETTER.)

In reply to your letter enclosing special report on explosions and fires in refrigerating machinery rooms, I am pleased to say that several years ago the writer made a very careful investigation of this subject, in order to demonstrate by practical experiment, in so far as this was possible, the causes of so called ammonia explosions in order to apply such remedies beforehand as would either eliminate them entirely, or reduce the possibility to a minimum.

The experiments were carried on at our Sargents Wharf plant, in which we have what is possibly the largest ammonia system in service, the working charge of which is sometimes as great as 100,000 pounds of ammonia, making it vitally important that every possible known danger of explosion be anticipated by proper safeguard.

We produced as near as could be obtained the supposed conditions which had caused explosions in other plants, and the result of our investigations, which seems very satisfactory to us, was as follows:

First: Ammonia "NH_3" as such, is not inflammable or explosive in air.

Second: There is, under certain conditions of operation, such as high temperature of discharge gases combined with moderate condenser pressures and high piston speeds, a slight decomposition of ammonia into its component elements, this being one atom of nitrogen and three atoms of hydrogen. The nitrogen is undoubtedly inert, but if the hydrogen has an opportunity to accumulate and segregate, it is very inflammable and highly explosive when mixed with a favorable proportion of air and subjected to ignition, either by contact with open flame or being subjected to a sufficiently high temperature.

We were unsuccessful in obtaining an explosion by detonation, such as might be expected to obtain in practical operation.

Third: It is customary in practically all compressor operation to use a mineral lubricating oil in the compressor cylinders, commonly known as ammonia cylinder oil, practically all of these oils which have a cold test below zero have a flash test of from 275 to 350 degrees Fahrenheit. American paraffin base oils running toward the lower range and Russian olefine base oils running toward the higher range.

Inasmuch as a temperature of 300 to 325 degrees Fahrenheit is not an uncommon occurrence in practice (we have noted occasionally in our own stations a discharge gas

temperature of 340 to 360 degrees on the mercury thermometers permanently connected for that purpose) the mineral oil used for lubrication, at this temperature, becomes nothing more nor less than a hydro-carbon gas, which, when subjected to ignition, is highly inflammable when mixed with certain proportions of air and highly explosive. when mixed with certain other proportions.

Fourth: Under ordinary conditions of operation and in ordinary temperatures, the lubricating oil becomes very finely atomized by churning, which obtains during the compression stroke and during the issuance of the gas and oil through restricted valve orifices, and this atomized oil is also inflammable or explosive when mixed with the proper proportions of air and ignited.

Fifth: With reasonable care in operation there is never air enough in the working system to provide the aforesaid mixtures, but the conditions necessary for an explosion may be readily produced with either hydrogen gas of the decomposed ammonia, or the hydro-carbon gases from the oil, escaping into the room in sufficient volume by reason of a mechanical rupture to the compressor or its piping, and subjected to ignition; this ignition being possible by contact with an open flame, electric spark, arc lamps in service and rarely by contact with the hot filament, especially of the larger incandescent lamps when broken, and more rarely by the mechanical rupture itself. The higher the gas temperature at the time of release and mixture,the more readily is the explosion produced.

(SECOND LETTER.)

I have your favor in reply to my letter in relation to the inflammability, etc., of gases in refrigerating machinery.

In answer to your question, "Do we understand that you were successful in obtaining explosions of hydrogen, resulting from the decomposition of ammonia, when mixed with favorable proportions of air and ignited."

I am pleased to say that we were successful in getting both inflammation and explosion from a segregated gas taken from the condensers of our compression refrigerating machines, and the same results were obtained with a sample taken from the absorber of one of our Absorption Machines.

That there may be no misunderstanding, I wish to explain that this gas when drawn from the condenser, or absorber, ignited and burned readily in the air as it issued. A small sample of this gas when allowed to stand for a short period so as to allow the lighter gas to come to the top and to be drawn off, was found to be hydrogen, which burned in the air as it issued,and,when mixed with certain proportions of air and ignited, was explosive, and when mixed with certain proportions of oxygen was very much more explosive.

As you are probably aware, practically all gases which are inflammable in air, or oxygen, are also explosive when a favorable mixture is obtained, the only difference between inflammation and explosion being in the time element of combustion; this time element being qualified by the intimacy and proportion of the mixture, and to the blanketing effect of any foreign or excess gas which may be in the mixture and which tends to slow down the chemical unition of the gases.

We were unsuccessful in obtaining ignition, at any of the temperatures of operation of the mixed gases as they existed enclosed in the system, and from our experiments, we are inclined to believe that this cannot be easily accomplished, for the reason, we have assumed, that under operating conditions there is never air and consequently oxygen enough in the system to accomplish this result: the small amounts which obtain being so separated and blanketed by the non-inflammable gas, that if chemical unition takes place,it is so slow and in such small quantity as to be negligible and not apparent from external observation.

The question of how much of this hydrogen gas is the result of ammonia decomposition, and just how much of it is hydro-carbon liberated from the lubricating oil at high temperatures, especially the friction temperatures between the piston and the cylinder, is just now a much mooted point. Our own opinion being strongly that a portion of it at least, is the result of the decomposition of ammonia.

A committee was appointed by the American Society of Refrigerating Engineers, of which the writer is a member, over a year ago, to "Determine the Sources of Foreign

Gases in Refrigerating Systems," but owing to the lack of facilities for concerted action very little was accomplished beyond proving that such gases were of quite common occurrence, and interesting the Bureau of Standards in the subject to the extent that a considerable sum has been apportioned for the purpose of constructing a small plant by the aforesaid Bureau at Washington, with a view to determining the facts under practical operating conditions.

In the July 1915, issue of the A. S. R. E. Journal, there is a very elaborate paper by Prof. R. Plank of Danzig, Germany,* which, while it is highly technical, is the most satisfying exposition of this subject that I have known, and it is especially so to us for the reason that it bears out theoretically the results which we have obtained by practical experiments, as well as furnishing hypotheses upon which we have been able to base satisfactorily the phenomena noted in practical operation.

Referring to your "Report on accident of April 26, 1915, Manhattan Refrigerating Company," and in reply to your question, "Do you think it is probable that this (ignition of hydrogen) is what occurred in connection with the explosion or fire incident to the liberation of gas from the plant using an Absorption System, in which there was probably little or no lubricating oil," I am pleased to say that from the description of the accident, it seems highly probable to me that the explosion was caused by the release of inflammable gases which were allowed to issue by the breaking of the pipe connection, and which had become segregated probably in the rectifier, and which were so intimately mixed with the air as to become explosive when ignited by embers in the forge.

I should expect that a portion at least of these gases was hydrogen resulting probably from ammonia decomposed in the generator.

It is a very common thing for this segregation to take place, especially in the rectifier if at a high point, and if not, in the absorber. In fact it is so common that in our large Absorption Machines we can purge at any time desired, gases which can be ignited as they issue in air, and it goes without saying that if these same gases were intimately mixed with air in favorable proportions, ignition would result in an explosion.

I am quite satisfied that this decomposition does take place in the generator of the Absorption Machine, especially when steam of high temperature is used, and more especially so, when zinc or zinc alloys are used in any part of the machine subject to contact with the ammonia.

I have found galvanized piping used, and have also found a considerable portion of zinc in what was supposed to be lead packings, gaskets, etc., and I have noted a metallic zinc deposit on the generator coils which could have formed only from lead packings in the analyzer which were almost entirely eaten away, a remnant of this packing being found upon analysis to contain quite a percentage of zinc.

Under these conditions, it is chemically possible to get a decomposition of ammonia, one of the results of which will be free hydrogen.

I would also suggest that it is easily possible for mineral oil, which may be used on the rods of the Aqua Pump, to work back through the packing into the other vessels of an Absorption Machine, with the possibility of developing an hydro-carbon gas, although I personally believe the possibility very remote under ordinary operating conditions.

We find continual evidence of the working back of this oil, as before stated, in our Absorption Machines, although of course the quantity is not large.

In reply to your final question, "Do you feel, as the result of your experiments, or in your experience, that the danger of igniting or exploding hydrogen, due to the decomposition of ammonia, is a fairly important hazard; or in other words, not one which is extremely remote?"

I have to say, that if you refer to internal explosion, that is, such explosion from this cause under operating conditions which would rupture a part of the machine, I think it is very, very remote, on account of the internal conditions as previously stated, and if you refer to *external explosion, due to the liberation of inflammable gases from either Absorption or Compression machines under conditions which may readily obtain during severe operation, I have to say that the possibility is undoubtedly very frequently present,*

*See abstract of this paper in *Power*, December 28, 1915; also editorial on same subject.

although the probability of getting the proper mixture and ignition when such gas issue is quite remote, as demonstrated by the comparatively few accidents of this nature which have occurred in refrigerating plants.

However, severely abnormal conditions of operation can be deliberately produced which will provide the hydrogen, the oxygen and the temperature for the explosion.

There is a self correcting feature nearly always present in the fact, that practically all refrigerating plants using ammonia are subject to more or less constant leakage, through defective joints, valve stems, packings, etc., and which leakage usually relieves the system of the lighter and more mobile gases, especially if these leaks are about the condenser, which is generally the high point of the system, and as a rule the more careless the operation of the plant, the more leakage; this condition thereby preventing automatically the accumulation and segregation of the inflammable gases, which constitute the real source of danger.

To the careful operator the presence of foreign gases in the system is very plainly indicated by the rise in both pressure and temperature, particularly the condenser pressure, which can be readily noted on the gages which no plant should be without.

Modern methods of storing and distributing perishable food stuffs are demanding an increasing use of refrigerating plants, and those having charge of the operation of the same would do well to post themselves thoroughly upon what may result from certain combinations of circumstances as outlined.

Recent Explosions in Refrigerating Plants.

I.

Butcher Shop and Dwelling.

339 Macon Street, Brooklyn, N. Y.

July 13, 1916, 10.11 a. m.

Special Report by William J. Tallamy (Member N. F. P. A.)

Construction.

The wrecked edifice was an ordinary four-story brick and stone building, with eight and twelve-inch walls, single light board floors on joists, wooden stairs, lath and plaster finish.

Occupancy.

The basement was used partly as cellars for dwelling tenants, and partly in connection with a butcher shop on the first floor. The basement contained a small refrigeration plant, ammonia-absorption system. On the first floor were the store and refrigerators. The upper floors were designed for living apartments, one on each floor. These were fortunately vacant at the time of the disaster.

Explosion.

This occurred in the front basement shortly after ten o'clock on the morning of Thursday, July 13, reducing the entire building and its contents to a mass of ruins, causing the death of all persons in the building at the

General View of Ruins of No. 339 Macon Street, Brooklyn, after Explosion of Ammonia Refrigerating Plant.

time and injuring a number that were in a passing street car, thirty-five feet distant.

The force of the explosion also tore two large holes several feet in diameter in the sixteen and twenty-inch stone and brick party foundation walls between the wrecked building and a similar building adjoining. The writer could see no evidence of fire having occurred before or after the explosion.

Cause.

In view of the total and practically instantaneous destruction of the premises, the direct cause of the accident can only be a subject of conjecture. There is however, unmistakable evidence that the explosion occurred in the basement at a point where the refrigeration equipment was located. As the refrigeration machine in use here was of a rather unusual type, its name not being available, the writer has endeavored to illustrate in the following sketch, its position, action and vital working parts from description.

The machine was undoubtedly an absorption type, closely resembling the Acme machine, in commission about nine years. The generator, absorber, analyser and rectifier being combined in a horizontal cylindrically shaped boiler heated apparently by gas from below.

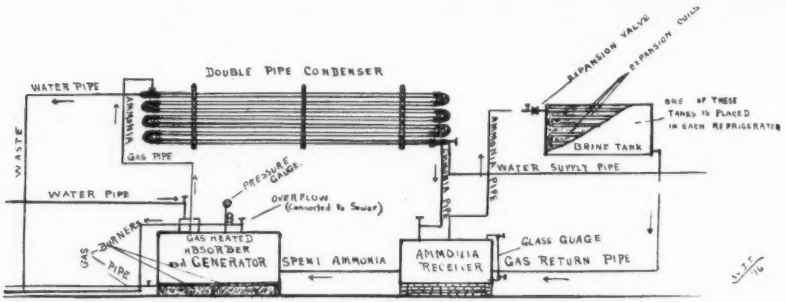


DIAGRAM APPROXIMATELY SHOWING REFRIGERATION PLANT BEFORE EXPLOSION.

EXPLOSION APPARENTLY OCCURED IN AMMONIA RECEIVER.

The usual twenty-five per cent to thirty per cent aqua ammonia solution was probably used in this boiler, the ammonia vapor being separated from steam given off in the boiling process by contact with iron pipes and small steel dome at the top, cooled with running water, and the ammonia vapor passing on through the condenser (double pipe), where it reduced to a liquid and was conducted to the ammonia receiver. From the receiver the ammonia was forced as desired to the expansion coils immersed in brine in this case.

The working pressure, as in practically all ammonia refrigeration systems, was probably between 150 and 200 pounds, this pressure being produced in the generator.

Attention is called to the size of the receiver as compared with the other working parts. With this type of machine the office of refrigeration could be performed several hours with the generator shut down, pressure in the receiver being retained by closing necessary valves.

The writer is convinced that *this accident was caused by an explosion of the refrigeration machine parts by excessive pressure from within.*

The plant was literally blown to pieces, the torn edges of sheet metal rolling outward, indicating force from within. The receiver, made of $\frac{3}{8}$-inch sheet steel with welded joints, was reduced to a distorted bent sheet of metal, warped and stretched in places, both heads being blown off. The condenser coils were broken in places, some joints being forced apart. The generator cylinder was intact, though both heads were blown off, the outward curl of the $\frac{3}{8}$-inch sheet metal edges indicating the result of the terrific force from within, which projected the shell against a wall with such violence as to crumple it considerably. The explosion force seems to have been noticeably greater at the receiver, though it extended through the condenser coils to and in the generator.

The overflow or relief valve shown at the top of the generator is said to have been missing at the time of the accident, which of course accounts for its not working properly and allowing the excess pressure to pass off through proper channels.

View of wrecked building 24 hours after explosion. Note hole in party wall.

Such an explosion might result from improper manipulation of valves and the lack of proper attention to the system while in operation.

For example, if the gas burners under the generator were lighted and the valves controlling the water supply to the condenser coils were closed, the generation of tremendous pressure in the system would be likely to follow. The explosion of an accumulation of foul gases in the receiver, condenser coils and generator, due to excessive heat, might also be the cause of such a disaster. This might follow if the condenser coils were not properly cooled.

View of wrecked receiver. Note curled edges.

Foul gases in ammonia refrigeration systems are explosive under favorable conditions. They probably result from the disassociation of gases in the solution. As they are ever present to a greater or less extent under proper working conditions, one can readily understand, how, if the cooling part of the refrigeration apparatus is not in proper working order, such gases might be present to an explosive degree.

It is the writer's experience that as small refrigeration plants require little attention when prop-

erly operated, owners have a tendency to lose sight of the dangers attending their use and frequently place them in charge of an inexperienced or otherwise incompetent employee. Such a practice should be prohibited.

The use of direct heat in absorption refrigerating plants, being highly objectionable, should be discouraged and steam heat substituted.

St. George Hotel, 51 Clark St., Brooklyn, N. Y.

August 6, 1916, 4.32 a. m.

H-11704. The refrigerating plant in which the above explosion occurred was located in the basement of the ten-story brick building at 51 Clark Street, about thirty feet back from the building line. It was installed about ten years ago by the Steel and Conduit Company of Jersey City, N. J., and had given satisfactory service in the interim. It was of the absorption type, of ten tons capacity.

At the time of the explosion it was in charge of the night engineer, who had been employed there for about two months and had not previously handled refrigerating machinery. At about 4 a. m. he was having trouble with the pump furnishing the water supply to the ammonia condensor, and consequently the generator pressure was rising and had reached 200 pounds, when he telephoned to, and received instructions from, the chief engineer as to what to do. He was apparently too excited to carry out these instructions. An attempt was made to change to another set of pumps, but in the excitement the discharge valve was left closed and no water delivered to the condensors. The pressure had mounted to 250 pounds and escaping ammonia made the engine room untenable. The engineer, after closing several valves, left the engine room and was on the stairs, when an explosion, which sounded to the clerk in the office above as a "big puff," occurred.

The explosion resulted from the failure of the head of the condensor, due to excessive pressure. The condensor was a cast-iron cylinder of metal, about 2¼ inches thick, with heads of similar thickness, bolted on by through bolts. The failure was by the breaking through of the head, approximately on a line with the inside surface of the cylinder, except that on one side the flange was broken across. The head was found only a few feet from the shell of the generator.

An examination of the valves immediately after the room became tenable showed the following conditions. The valve from the generator to the condensor was shut. The steam was shut off from the coils in the generator. The weak liquor return from the generator to the absorber was shut. The pump delivering aqua ammonia from the absorber to the generator was running. The result was that, all outlets of the condensor being closed and the pump still running, the head was simply pushed out of the generator by the hydrostatic pressure developed.

There was no relief valve on the apparatus. There was no external explosion or fire, although there was an open gas flame to light the gauges.

The explosion or break did no damage other than blowing the doors of the engine room from their hinges and the damage to the refrigerating plant itself. The escaping ammonia found its way up through the hotel, however, and caused considerable confusion and alarm among the hotel guests, many of whom were affected by the ammonia fumes, although only two to such an extent that they had to be removed to the hospital.

Conclusions.

Every refrigerating plant should be equipped with a safety valve to guard against excessive pressure. It is also advisable to have some form of automatic cut-out to stop the compressor or pump if the pressure runs too high.

Refrigerating plants in places of public assembly should preferably be located under sidewalks or courts, and should have outside ventilation. They should also be cut off by substantial fire walls and tightly fitting fire doors from the building proper.

Department of Fire Record.

Clothing Factories — Fire Record.

A previous study of the fire record of clothing factories appeared in the QUARTERLY for July, 1907, and notwithstanding the disparity between the number of fires then available for review, viz., 125, and the number reported from that time to the present, viz., 774, one or two interesting comparisons can be made. It is noteworthy, for example, that among fires of known origin the proportion attributed to the special hazards of the industry, which was 52 per cent on the earlier occasion, in the present record is no more than 28 per cent. Two principal factors have contributed to this change — one encouraging, the other alarming. On the one hand, the special hazard arising from spontaneous combustion among waste clippings, etc., has been greatly reduced, while on the other the number of fires due to the common smoking hazard is so excessive as to call for separate consideration.

When we find careless smoking giving rise to 173 fires (or 9 more than all the "special hazard" fires taken together) and when 11 of the 45 "large loss" fires from known causes are traceable to the same source, it almost becomes a question whether in the clothing industry smoking should not itself be considered a "special hazard." Some employers have even stated that it would be impossible for them to keep their employees if smoking were entirely prohibited on their premises, and there seems to be general agreement as to the difficulty of enforcing the prohibition even in the manufacturing rooms. The underlying causes for the attitude of the workers are matter for independent investigation, but it would seem that until their co-operation is secured in safeguarding the factories, the smoking hazard in the clothing industry must remain a serious problem. In this connection it has to be remembered that surreptitious indulgence in smoking, if practised to any considerable extent, is attended with special hazard, inasmuch as the most obvious means by which an employee might escape detection would in many cases be to throw his cigarette under the cutting table where it might smoulder unobserved among clippings or other rubbish. Before passing from this topic, it should be said that a livelier sense of the danger of smoking while at work can hardly be expected from the workman so long as his employers or superintendents remain indifferent to it. The record includes more than one fire attributable to careless smoking in the factory by those who should set an example.

After smoking, the largest individual cause of fires is the pressing iron.

It will be observed that responsibility may be apportioned about equally between electrically and gas-heated irons, the number of fires known to be due to irons of one class or the other being 49 and 48 respectively. The most common cause of fire was the inadvertent leaving of gas or current turned on the iron after use. Generally metal or other stands are provided for the irons, but in one or two instances the irons were carelessly left standing directly on wooden tables or on cloth laid on the tables. Much can be done to lessen the hazards attendant upon the use of these irons by turning off the gas nightly at the meter, where gas irons are used, and by having electric irons protected by pilot lamps or some other safety device. It is, however, necessary to emphasize the fact that such precautions are liable to fail of their purpose if they are regarded in any way as canceling the obligation to exercise a full measure of ordinary care. Such flagrant cases of neglect as failure to turn off electric current notwithstanding the warning glow of the pilot lamp are in a category by themselves; but there is a class of fire traceable to over-reliance upon mechanical safeguards, which though somewhat exceptional deserves brief notice. A good illustration is afforded by two fires due to electric and gas irons respectively. In the first case a proprietor glanced at the pilot lamp and assumed that the current was off the iron. As a matter of fact the lamp had simply burnt out, and fire resulted. In the other instance, gas was regularly turned off at closing time, but this did not prevent a fire arising from the carelessness of an employee who left an iron standing on a wood table top instead of on the provided stand. The heat remaining in the iron was sufficient to start a fire.

The waste clipping hazard, though responsible for a comparatively small proportion of the total number of fires, is noteworthy as the cause of 5 of the 14 "large loss" fires due to the special hazards of the industry. Clippings should not be allowed to accumulate on floors nor in basements, but should be stored in metal-lined bins. Moreover, the special clipping hazard is very closely connected with the common rubbish (or sweepings) hazard. The proportion of fires under the latter head is, perhaps inevitably, somewhat high, but there is evidence to show that considerable improvement could be effected by better housekeeping. The excessive smoking hazard renders it essential to pay particular attention to waste bins, which should be metal or metal lined and provided with proper covers. The quantity of clippings and rubbish on the premises should be kept at a minimum by regular removal.

The value of the automatic sprinkler as an agency for reducing the number of "large loss" fires is not so apparent from the tables included in this record as it has been in the case of some other classes of property that have been studied in the QUARTERLY in recent years, but this is largely explained by the fact that a very considerable number of fires break out in boxes under large cutting tables. In these circumstances the opening of sprinkler heads is sometimes delayed and the distribution of the water is not infrequently obstructed. Even so, in sprinklered factories the proportion of fires reported as involving large loss is hardly

more than one-half of the proportion so reported among all classes of clothing factories. Where sprinklers have been provided underneath the tables and in storage bins for clippings, highly satisfactory results have been obtained.

CLOTHING FACTORIES — FIRE RECORD.

Total Number of Fires Reported, 774.*

1. Classification of Causes.

Summary.

Common Causes.

	No. of Fires.	Per Cent of Common Causes.	Per Cent of Known Causes.
Heating	26	6.6	4.5
Lighting	26	6.6	4.5
Power	25	6.4	4.3
Electrical causes 23			
Lightning	4	1.0	.7
Smoking	173	44.2	29.8
Independence Day	3	.8	.5
Chimneys and Flues	4	1.0	.7
Matches	16	4.1	2.8
Boiler (or fuel)	4	1.0	.7
Rubbish (or sweepings)	67	17.1	11.6
Oily Material	22	5.6	3.8
Miscellaneous	22	5.6	3.8
Total	392	100.0	

Special Hazard Causes.

	No. of Fires.	Per Cent of Special Hazard Causes.	Per Cent of Known Causes.
Waste Clippings	24	14.6	4.1
Volatile Liquids used for Cleaning	15	9.2	2.6
Pressing Irons	111	67.7	19.1
Electrically heated 49, gas heated 48, stove heated 1, unclassified 13.			
Rubbish Chute	2	1.2	.3
Dry Room	2	1.2	.3
Miscellaneous	10	6.1	1.7
Total	164	100.0	
Common Causes	392		67.6
Special Hazard Causes	164		28.2
Incendiary	15		2.6
Exposure	9		1.6
Total Known Causes	580		100.0
Unknown Causes	194		
Total	774		

*Data from 209 Fire Patrol reports, used here and in Table 3, not sufficiently complete for use in all the tables.

Details of Causes.

Under this heading are given brief descriptions of fires caused by unusual conditions or of an educational value in emphasizing the different hazards. Fires caused by ordinary conditions or well understood hazards may not be included.

Common Causes.

Heating.

H-4849. Hot ashes from a heater in a cellar caused fire. A hole was burned in the flooring above and a quantity of stock on the first floor was set alight, considerable smoke and water damage resulting on floors above. The premises were without a watchman or any automatic fire equipment, but two employees sleeping on the first floor were awakened by the smoke.

Lighting.

S-10830. A movable gas jet was swung to a position under the transom of a doorway and the door was pushed to. The transom was badly charred in the few minutes before the accident was noticed.

S-10688. Finished clothing had been packed tightly around an unprotected electric light bulb on a shelf, but current was off at the switch. On the morning of the fire a visiting electrician tested out the circuits, turned current into this line, and left the light burning. Cloth began to smoulder but fire was promptly discovered and extinguished. No sprinklers opened.

S-17906. This fire was caused by a short circuit where an electric light cord was in touch with a metal clothes rack. Current was not turned off, a short circuit ensued, and practically all garments on the rack were damaged. A table nearby was also slightly charred.

Power.

H-4673. The gas regulator used in connection with a natural gas engine located at rear end of basement was a sheet metal gasometer with oil seal. A valve of "stop cock" type in the two-inch gas supply pipe was operated by an arm fastened to an iron post on top of the inner cylinder of the gasometer, this arm being also attached to the lug of the valve, with a bolt so arranged that when the gasometer was full, the arm would close the valve in the supply pipe. The bolt holding the arm to the valve broke when the engine was stopped, and the inner cylinder of the gasometer blew off, the gas being liberated through a two-inch outlet extending above the oil seal. The liberated gas was ignited by an open gas light, causing an explosion. The building was gutted, but all rear openings having been protected by good tin-clad fire shutters, a large brick building eight feet distant, with numerous unprotected openings toward the burning premises, suffered very little damage.

H-5230. Mismanagement by an employee caused a short circuit on the wires of an electric motor located on the third floor, resulting in a firing of the insulation and throwing of sparks among surrounding inflammable material. The fire spread rapidly and extended to the floor above. A panic occurred and several lives were lost by leaping from windows and suffocation. The employees were mostly women.

S-18593. A three horse-power induction motor was directly connected by belt to a small circular saw used for cutting box shooks to dimension when these did not assemble properly. The saw had been in service on the afternoon of the fire. Power had been shut off, when smoke was observed curling from the wooden box in which the motor was enclosed. The fire was promptly extinguished with chemical extinguisher. Bearings had apparently gone dry, and probably friction caused heat or flame sufficient to ignite the film of sawdust in the box.

Smoking.

H-3247. This fire caused a loss of more than $16,500. The firm, which was doing a good business, was put to the inconvenience and expense of securing and fitting up new quarters. Smoking, the cause assigned for the fire, was a continuous habit among the employees.

S-8578. Smoking was permitted on these premises and the person who threw the lighted cigarette which caused the fire, into the box of clippings in which the blaze occurred was evidently **the private watchman employed by the firm.**

S-9910. In this case a cigarette butt appears to have been left on a bench, and a pile of clothing in process of manufacture to have been thrown on top of it.

H-5106. About an hour after this plant had closed for the day, a disastrous fire broke out in the stock room, involving a loss of more than $30,000. The fire was evidently due to smoking.

S-16121. This fire was evidently caused by smoking, and it transpired on investigation that the superintendent of the floor on which the fire broke out had been smoking after the other employees had left. It is supposed that he threw a lighted match or a cigarette on the floor shortly before leaving.

S-17122. The loss occasioned by this fire was about $11,250. A smouldering cigarette or match was evidently the cause of the blaze, which started in the direct line of retreat from a toilet. The employers were known to smoke on the premises.

S-17827. This fire occurred in a small refuse box, and was confined thereto by automatic sprinklers. Several cigarette stumps and boxes were found among the contents of the box immediately after extinguishment of the fire.

S-17896. A handful of cigarette butts was picked up off the floor of the section in which this fire originated. The floor was kept in a very dirty condition generally, and a considerable amount of dirt and rubbish was found behind radiators and under machines.

Suspected Smoking.

(Owing to insufficiency of evidence these fires appear in the tables as of unknown origin.)

S-6663. This fire broke out under the head of a couch in employer's office. Brushes and linings were stored underneath the couch. Employer smokes but does not remember lighting his pipe before leaving on the day of the fire.

S-7577. It is thought probable that a salesman, who, when the factory closed on the day of the fire, was on the floor on which the outbreak occurred, threw away a match on lighting his cigar, and set fire to paper boxes containing cotton shirtwaists.

S-10568. An old stairway was blocked off at the bottom, and the space used for deposit of cuttings which, after accumulation, were to be bagged up and sold. Old lunch papers and odds and ends appear to have been thrown among the cuttings, and it is quite likely that a cigarette or match was responsible for the fire which occurred in the stair enclosure.

Rubbish (or Sweepings).

S-9070. A waste can containing sweepings, etc., was left unemptied on the evening of the fire. When fire was discovered in the can, it must have been burning for at least an hour, as the hardwood floor underneath was found to be charred from one-half to three-quarters of an inch deep.

This fire emphasizes the necessity of disposing of all waste, sweepings and rubbish each day, regardless of quantity.

S-11707. Sweepings and waste paper were deposited in a large open top wood box which was emptied daily. Fire was confined to the box, but considerable water loss was incurred.

S-15891. Rags and waste paper were removed daily to a small room on the first floor where they were compressed. A blizzard interfered with the regular removal of the rags, etc., and fire broke out in the rag room. The fire door was blocked open and could not be closed. Shortly before the fire was discovered, the watchman on his round passed the door but noticed nothing unusual.

Oily Material.

S-17504. Fire originated under a cutting table on which linseed oil had been spread for the purpose of smoothing the surface. Spontaneous combustion is supposed to have occurred in a basket of flannel cuttings which had been left under the table and had become saturated with the oil.

Miscellaneous.

S-7603. Sprinkler alarm wires ran open through the property from the alarm valve to an obsolete porcelain block cut-off near the outlet, and thence overhead on poles to the central station. Owing to a storm all overhead wires were heavily coated with ice, the weight breaking down telephone and other wires in many places, these wires in falling coming in

contact with the electric railway trolley and lighting wires. The trouble was caused by the cross (apparently in the vicinity of a building approximately 600 yards distant), but had the electric connections from the sprinkler alarm valve been properly installed there would have been no short circuiting with outside wiring, and the fire would not have occurred.

This fire shows the necessity for approved cut-outs or heavy current protectors at entrances to buildings on all signal circuits, of whatever nature.

H-3977. This fire, which was attended with a loss of approximately $40,000, started in a shingle roof, and is attributed to a flying ember of burning paper from the furnace.

H-7096. Owing to the fact that there was only one floor opening, and that an enclosed stairway, fire was confined to the basement. The watchman who telephoned for the fire department was, however, unable to make his escape and was burned to death. The fire was apparently due to spontaneous combustion in a large pile of soft slack coal resulting in the formation of inflammable and explosive coal gas. The coal was in a moist condition, perhaps caused by leaking pipes, and was piled adjacent to the fire box of the steam boiler.

The lesson to be learned from this fire is that careful attention should be given to the conditions of boiler rooms, and that fine slack soft coal should be stored in large quantities only in isolated sheds or in specially constructed coal rooms.

S-15635. It was the custom to leave electric lights in the stair tower burning until 6.30 p. m. Employees leaving at a later hour were accustomed to light their way downstairs with matches or paper. Fire was probably caused by carelessly thrown match or cigarette.

S-17858-A. A quantity of charred paper and refuse was found behind a radiator and steam pipe in the toilet in which fire originated. In front of the pipe was a ten-gallon can of germicide which when tested was found to be very inflammable. No doubt some of the germicide was spilled on the refuse and, coming in contact with the steam pipes, was ignited.

S-18594. This fire occurred in a small room in the basement. The room adjoined the boiler room, and the smoke flue from the heaters passed through it. It was used for the storage of empty packing cases, paper, cloth cuttings and general rubbish, and was in a very congested condition, as cases, etc., had been allowed to accumulate in it while other parts of the building were being cleaned up. The cases, etc., were piled nearly to the ceiling and in places against the flue. When the engineer started the boilers he failed to notice the position of the rubbish and the defective covering of the flue, the metal of which was exposed in several places owing to improper hanging and to damage done by the cases to the asbestos cement covering. The fire occurred close to one of the exposed places, and as charred pieces of paper were found on the flue and in an open box beside it, it is probable that the paper caught fire and fell upon a pile of cuttings beneath. Two sprinklers opened, but as there was no outlet

for the smoke it was impossible for the firemen on their arrival to know the size of the blaze. One hose stream was laid and operated for a few minutes. The damage was slight.

Special Hazard Causes.

Waste Clippings.

H-2205. Fire seems to have originated in a heap of clippings, etc. No proper provision was made for the storage of clippings, which were allowed to accumulate in unoccupied hallways and rooms.

H-5320. Clippings were taken from the floor each day and deposited in the basement in boxes. The fire originated in these boxes and entailed a heavy loss, which would probably have been avoided by the use of metal-lined bins.

Volatiles.

H-6237. A small bottle of gasoline was knocked off a table, a portion of the contents falling on clippings, and a portion falling on a hot flatiron. The blaze was extinguished by the employees.

S-6327. This fire was due to an explosion of gasoline vapor in a tailor shop directly under a celluloid factory. There was not more than a gallon of gasoline in the room, but the tailor had been cleaning many clothes. These were hanging around the room, which was therefore full of vapor. The flames extended outside the building, cracked the windows on the floor above and entered the celluloid factory, attacking a box of celluloid combs in process, but the blaze was held in check by sprinklers.

H-10834. A tailor cleaning clothes in gasoline, with gas for light, was burned to death following an explosion. One building was totally destroyed and two others were damaged.

Pressing Irons.

S-10578. A workman, on leaving, forgot to extinguish the gas under his pressing iron. The gas used was under air pressure, and, after the foreman had shut off the motor, the flame was left burning under light pressure — a fact which considerably delayed the outbreak of the fire. The irons rested upon cast iron stands with an open space of four inches between the bottom of the stand and the table, the top of which presented a hard surface for the fire to attack.

S-17265. In this case the iron had a metal stand and the table underneath was covered with asbestos. Gas being left on after use, the iron overheated and burned a hole not only through the table, but through a frame partition very close to which it was set. A wooden canopy twenty-four inches wide, under which clothing was hung on an iron rod, prevented the sprinklers from entirely extinguishing the fire.

S-18524. An electric iron, with current turned on, was left standing on a wooden table covered with tin, the tin being covered in its turn with cloth. The iron ignited the cloth covering; this burned around the edge

of the table, fell to the floor, and set fire to some clippings. The sprinkler that opened would have entirely extinguished the fire but for the obstruction offered by the table.

Miscellaneous.

H-8206. This fire was attributed to a ruching machine with a gas-heated iron cylinder, four inches in diameter, open at each end. The inside of the cylinder, upon which a small air-forced gas flame bore, probably became coated with dirt. It was claimed that a spark from this dropped into a basket of finished ruchings immediately under the machine, and caused the light cotton material to flare up. Before being extinguished, fire spread to another basket of the same material.

H-8850. In this case two floors were completely gutted, and much damage done on another, by a fire breaking out in the basement at the bottom of the rubbish chute. The chute, which was nearly always choked with clippings, was constructed of wood vertically from the basement to the third floor, thus affording quick access for the fire.

Chutes should not be constructed of combustible material.

S-8328. It is believed that a spark lodged in one of the quilted cotton holders with which irons were lifted from the gas stoves used for heating them. On ceasing work, employees were accustomed to throw their holders on tables covered with cotton cloth, and the fire is supposed to have resulted from the smouldering of the spark.

S-18884-A. A small heater for furnishing steam used in moistening fabrics rested on one-inch iron legs over sheet-iron clad floor boards. The gas flame was not shut off at the end of the day. Surrounding the heater on three sides were light board partitions forming the backs of tiers of narrow stock shelves. Fire was apparently due to slow charring and eventual ignition of the hard maple top flooring nailed to sleepers in the cinder-fill over terra cotta floor arches; it spread along the floor to the partitions and shelves already mentioned, which may have obstructed sprinkler distribution to some extent.

This fire emphasizes the importance of properly setting heaters of this sort, when located over combustible flooring, on a substantial base of fire brick and sheet iron, and of maintaining sufficient clearance on all sides.

MISCELLANEOUS STATISTICS.

2. Analysis of Loss.

	Common Causes.		Special Causes.		Unknown Incendiary Exposure.		Total.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
No Claim	31	13	10	12	2	1	43	9
Small Loss	185	74	62	72	105	60	352	69
Large Loss	31	13	14	16	67	39	112	22
Total with data given	247	100	86	100	174	100	507	100
No data	12		7		39		58	
Total	259		93		213		565	

3. Day or Night Fires. (Day Fires 6 a.m. to 6 p.m.)

	Common Causes.		Special Causes.		Unknown Incendiary Exposure.		Total.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
Day	136	35	42	26	35	16	213	28
Night	253	65	119	74	180	84	552	72
Total with data given	389	100	161	100	215	100	765	100
No data	3		3		3		9	
Total	392		164		218		774	

4. Plant in Operation.

	Common Causes.		Special Causes.		Unknown Incendiary Exposure.		Total.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
Plant in Operation	39	16	17	20	21	12	77	15
Plant not in operation	204	84	70	80	159	88	433	85
Total with data given	243	100	87	100	180	100	510	100
No data	16		6		33		55	
Total	259		93		213		565	

5. How Discovered.

	Common Causes.		Special Causes.		Unknown Incendiary Exposure.		Total.	
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.
Employee	44	17	15	17	18	10	77	15
Watchman	17	7	10	11	12	7	39	8
Thermostat	25	10	4	5	9	5	38	7
Sprinkler Alarm	124	50	37	42	58	32	219	42
Outsider	32	13	20	22	82	45	134	26
Supervisory	7	3	3	3	1	1	11	2
Total with data given	249	100	89	100	180	100	518	100
No data	10		4		33		47	
Total	259		93		213		565	

SPRINKLER FIRE RECORD.*

6. Effect of Sprinklers.†

	No. of Fires	Per Cent of Whole
Extinguished or Practically Extinguished Fire	285	85.1
Held Fire in Check	47	14.0
Unsatisfactory	3	.9
Total	335	
No Claim	31	9.3
Small Loss	268	80.0
Large Loss	36	10.7
	335	

*There were thirty-three fires in which the heat was insufficient to open any sprinklers.
†Four fires included in this table are omitted from subsequent tables owing to insufficiency of data.

7. Number of Sprinklers Opened.

No. of Sprinklers Operating	No. of Fires.	Per Cent.	No. of Sprinklers Operating	No. of Fires.	Per Cent.
1	184	55.6	1	184	55.6
2	53	16.0	2 or less	237	71.6
3	37	11.2	3 or less	274	82.8
4	25	7.6	4 or less	299	90.4
5	9	2.7	5 or less	308	93.1
6 to 9 inclusive	11	3.3	Less than 10	319	96.4
10 to 24 inclusive	4	1.2	Less than 25	323	97.6
25 to 49 inclusive	6	1.8	Less than 50	329	99.4
50 and over	2	.6	50 and over	2	.6
	331	100.0			

Average number of sprinklers opened, not including unsatisfactory, 2.84

Unsatisfactory or Large Loss Sprinkler Fires.

S-7437. This fire occurred a few minutes after the plant had shut down, only a few employees being left at work. One cutter, who was endeavoring to finish up his work before going home, was unwinding netting at the cutting table. The netting came into contact with an open gas flame and burned very quickly, communicating the flames to other light materials near at hand. Six sprinkler heads opened and practically extinguished the fire, but the firemen were unable to find the valve controlling the sprinklers. After the water had been running for about half an hour, new heads were put in and the flow stopped in that way. The loss was mainly water damage.

S-8424. The loss in this case was mainly water loss on floors below the top floor, where the fire originated. The fire department seems to have made a serious blunder by entering an adjoining building and allowing more than half an hour to elapse before locating the fire and shutting off the valve controlling the operating sprinklers. A considerable loss in the basement is traceable to leaky elbows in a standpipe line connected to fire engines outside.

S-9499. No less than eighty-five sprinkler heads opened in this case. The fire, which was evidently a very hot one, was held for a considerable time under a large cutting table set near to a brick wall, but as more and more sprinklers opened and reduced the amount of water discharging from the heads nearest to the wall, the flames at length succeeded in getting out on one side and setting fire to patterns and shelving on the wall. The building suffered little, thanks to its excellent construction, but the water loss was heavy. The fire was described in some detail in the QUARTERLY for April, 1910 (p. 501).

S-10344. This fire occurred in the stock room in some cotton piece goods and laces, well skidded on the floor. The opening of sprinklers and the distribution of water were, however, seriously obstructed by a large rack, located immediately above the goods that had taken fire and piled with paper boxes to within thirty inches of the ceiling. Nevertheless

the sprinklers held the fire in check and doubtless saved the entire premises, as the fire spread rapidly along tables and skids containing stock.

S-10460. Almost all the loss from this fire was caused by water damage due to the opening of the thirteen sprinkler heads required to hold a very quick hot fire in check. The fire would undoubtedly have been entirely extinguished in its incipiency had sprinklers been installed under the cutting tables, beneath which, as so often happens in this class of factory, the fire succeeded in getting a hold.

S-10523. In this case the sprinklers were of an old pattern. Forty-six heads were found open, but thirty-four of these bore unmistakable evidence of having been broken open. The solder joints were still intact and there were bright scratches made by some sharp instrument on the yokes of the heads. The watchman, when questioned, stated that he had gone his rounds regularly and registered at all clock stations in the usual manner. He did not hear the sprinkler alarm but heard water running through the building. He was unable to account either for the absence of any clock registry of his four o'clock round (in the course of which he claimed to have heard the water) or for an interval of fifty minutes which seems to have elapsed between that time and his arrival at the patrol house two squares from the building.

S-11533. A private police officer who acted as outside watchman for a number of stores, etc., in the neighborhood, observed water dropping from the upper edges of the windows of the first floor. A small amount of water was also flowing from the front door. The outside electric sprinkler alarm bell did not ring, and considerable delay occurred before access was obtained to the premises and the cause of the trouble ascertained. Probably the sprinklers had been operating for about an hour when they were discovered.

S-15889. An employee doing janitor work in the building heard the alarm bell ring and after waiting awhile decided that something had short-circuited the bell. He then disconnected the batteries of the alarm system. The building was entirely protected by a burglar alarm system and the employee was afraid to investigate through the building. Water finally dripped down through stair and elevator shafts to the boiler room in the basement. The employee then became alarmed (thinking a water pipe had burst), telephoned to the engineer and was instructed to take a trip up the elevator shaft. On arriving at the seventh floor he smelled smoke and opened the elevator door, which operated the burglar alarm and brought police to the building. The police notified the Insurance Patrol by telephone, and the fire was discovered completely extinguished. In the meantime the sprinkler tanks had been exhausted.

S-18572. Fire was discovered on sixth floor in a concealed joist channel in the wood lath and plaster ceiling of the floor below. The fire, which originated in a small quantity of rubbish, evidently collected by rats or mice, made its way several feet along the joist space and up

through a small opening around a cast-iron post to the floor above, where the heat opened one sprinkler head. The Insurance Patrol, finding the fire concealed in the ceiling, notified the city fire department. The firemen chopped away the floor and ceiling enclosing the joist channel, and extinguished the blaze with chemical extinguishers.

S-18825. Nearly two hours seem to have elapsed between the discovery of the fire and the notification of the fire department. The owner of the building was found to have been on the premises for a considerable time when the firemen arrived. He had done nothing, he explained, because he did not know what to do. Investigation was then made and sprinklers were found operating on the top floor, where a fire had been in progress. The gate valve controlling the sprinklers on the top floor was closed and rubber blankets were spread on various floors below, but probably too late to be of much service, the water having already leaked through all floors. An interesting feature connected with the operation of the sprinklers was the fact that there was an accumulation of leaves, grass and twigs caught on the deflector of the sprinklers that had operated. On removing the sprinklers large pieces of leaves were taken from the pipes. To all appearances, however, the sprinklers had operated properly, the leaves not stopping the flow of water. The presence of these leaves, coupled with the failure of the sprinkler alarm to operate, would tend to indicate that this failure was due to a stoppage of the alarm connections by leaves or other foreign matter.

Points of Interest from Fire Reports.

Automatic Sprinklers.

S-6724. The distribution of water in this case was seriously obstructed by the wide cutting table under which the fire arose. Although the sprinklers were unable to extinguish the fire they prevented it from spreading. There was some water damage.

S-8444. This fire had probably gotten quite a start before sprinklers operated. The cutting table which delayed the opening of the sprinkler heads also kept them from doing more than holding the fire in check pending the arrival of the fire department. The loss on one floor amounted to more than $4,000, and other floors were affected.

S-10141. Sprinklers were provided beneath the large deck under which the fire broke out. Had this not been the case, the fire would have gained considerable headway before the ceiling sprinklers would have operated. The blaze was entirely extinguished with but slight loss.

S-10383. There was heavy water damage in connection with this fire. The sprinkler system was of an unapproved type and it was found that a few of the heads, including one located almost directly over the spot at which the fire is supposed to have originated, were constructed to fuse only at a temperature of 300 degrees. Moreover, the supply of water evidently did not last a great while, nor did it furnish much pressure

under a heavy draught. The stock which caught fire was very light and must have taken some little time to generate a high degree of temperature; and further it was stored in bins offering obstruction both to the rising of the heat and the distribution of the water. Nevertheless the sprinklers held the fire in check and unquestionably prevented a still more serious fire.

S-17157. Eight sprinkler heads opened and though they were unable to prevent the flames from spreading underneath a table adjoining that beneath which it originated and from charring an adjacent frame office enclosure, they held the fire in check until it could be extinguished by members of the fire department and insurance patrol with hand chemicals. The space underneath the tables was not divided into compartments nor provided with sprinklers. Owing to the density of the smoke, the floor valve controlling the sprinklers was inaccessible, and the main valve under the sprinkler tank was not found. The tank was therefore allowed to empty, and considerable water damage resulted.

S-17567. Fire originated in a metal-lined bin containing a heavy body of clippings and rags. The sprinkler in the bin opened, completely extinguished the fire, and prevented all loss except loss of stock in the bin.

S-7032. This was an exposure fire. Two shaft openings about twelve inches square allowed fire to pass from an adjoining building through the wall in the second story, but one sprinkler opposite each opening kept the fire out of the building. Although the roof of the adjoining building was completely burned off and its second floor gutted, the two sprinklers and a single fire door saved the property. The loss consisted entirely of water damage to varnished woodwork.

S-9218. Waste paper sweepings and bags were stored in a brick vault under the sidewalk until the accumulation amounted to a wagon load, when it was removed. The vault was cut off with a tin-clad fire door. A cigarette butt, dropped from the sidewalk through a broken bull's eye in a manhole plate at the top of the vault was the cause of the fire. Two sprinklers operated and practically extinguished the fire. The water was absorbed by the bags of paper without damaging any stock on the basement floor. So effective was the work of the sprinklers that the small amount of wooden moulding enclosing thermostat wires and a wooden box enclosing electric batteries located in the vault were hardly scorched.

Watchman.

S-6206. When this fire occurred, the night watchman, who also keeps up fires, was out attending to duties in another building for which likewise he is fireman. On his return he heard the sprinkler alarm and was met by a first floor tenant whose store was being flooded with water. The two went up on the elevator and discovered fire in a rubbish box on the fifth floor. The fire pails being partly empty had to be refilled at a faucet. The fire was then completely extinguished and the sprinkler turned off. Water damage was done to the extent of about $1,000.

H-4097. A watchman's service was maintained at all times when the plant was shut down, except on Saturdays from noon until 5 p. m. Fire occurred on Saturday afternoon while the watchman was not on duty, and involved a loss of $22,000.

S-13450. It seemed evident that this fire had been smouldering for some little time when discovered by an employee arriving for work. Upon inquiry into the failure of the watchman to discover it on his regular rounds, there was a conflict of testimony as to the instructions given to the watchman as to the method of making his rounds. According to one account it was the watchman's duty merely to pass through the basement of the main building on his journeys to boxes in the east and west wings. In opposition to this it was claimed that the man was supposed to pass through each floor of the entire plant on his rounds.

S-14585. The watchman extinguished this fire with a couple of pails of water. He did not, however, know how to shut off the sprinkler which was operating. Two hours were spent in looking for the janitor who was out for the evening and could not be found. In the meantime the sprinkler tank almost emptied itself. The loss was entirely due to water damage.

These fires emphasize the fact that the value of a watchman service depends largely on the constant presence of the watchman and his undivided attention to duties which are clearly explained to him.

Fire Door.

H-8965. When the firemen arrived on the scene, they found the fire coming through a large skylight. They carried a line of hose up the stair and elevator tower and tried to break open the fire door, which was locked with an ordinary lock and a special police lock. The latter lock had been installed some six months previously in consequence of a burglary, and it was only after four or five minutes work that the firemen were able to gain access to the room. By that time the heat had grown so intense that they were forced to abandon their position. The fire gained rapid headway before a stream could be put on, and a heavy loss resulted.

Miscellaneous.

H-2683. This fire in an unsprinklered building entailed a loss of about $30,000. It started near the center of the second floor, spread over the entire floor, broke through windows and entered the third and fourth floors through windows on the street side. It also crept up along posts through small openings between the third and fourth floors, and began to drop through from the second to the first floor in a similar manner. Sliding tin-clad fire doors on the stairway shaft worked satisfactorily. Rolling shutters on the elevator shaft failed in several instances, but the fire was under control before it reached the elevator shaft strongly enough to do any damage by this means of communication.

Automatic sprinklers, thermostats or watchman might have reported the fire and given an alarm before it could have gained such headway,

and metal frames and wired glass would have kept the fire from entering the third and fourth floors through the windows.

H-7103. By the use of chemicals and some water this fire had been gotten under control and confined to the room in which it had broken out. The fire chief, seeing that all danger was past, and unaware that nearly ten gallons of gasoline were in an open tub on the floor below, ordered the firemen to use lath hooks and remove burning laths. Falling laths ignited the vapors already formed and set fire to the gasoline, causing an explosion which blew out a plate glass front and started the fire anew. Water was once more turned on and the fire soon extinguished, but not before a large stock of furs had been damaged by water, smoke and heat.

S-19030. This fire was discovered when water from sprinklers ran down into the floor below and caused a short circuit on the wires of the burglar alarm system, which led to investigation. A tenant working on the lower floor had earlier heard the sprinkler alarm ringing but paid no attention to it until water began to come through onto his plant. Three sprinklers, considerably obstructed by a table, were found holding the fire in check, but inasmuch as the sprinkler tank was by this time nearly empty, it is probable that had it remained undiscovered much longer the fire would have gotten beyond control.

8. EFFICIENCY OF WATER SUPPLIES TO SPRINKLER SYSTEMS.

Primary Water Supply.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Number and Per Cent. of Fires. Extinguished fire (or practically extinguished)		Held fire in check		Unsatisfactory		Average Pressure. Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Average Number Sprinklers Opened. Extinguished fire (or practically extinguished)	Held fire in check
Water works,	55	16.6	67	2.49	46	83.6	9	16.4	....	....	69	53	....	2.13	4.33
Gravity tank,	53	16.0	24	5.98	36	67.9	16	30.2	1	1.9	25	22	12	4.94	8.31
Pressure tank,	216	65.3	94	2.13	196	90.7	19	8.8	1	.5	94	94	75	1.91	4.47
Automatic pump,	7	2.1	81	3.85	7	100.0	.....	.....	....	....	81	....	....	3.85	.....
Total,	331	100.0	78	2.84	285	86.1	44	13.3	2	.6	81	59	43	2.37	5.83

9. EFFICIENCY OF WATER PRESSURES ON SPRINKLER SYSTEMS.

Pressure on Sprinklers.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Number and Per Cent. of Fires. Extinguished fire (or practically extinguished)		Held fire in check		Unsatisfactory		Average Pressure. Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Average Number Sprinklers Opened. Extinguished fire (or practically extinguished)	Held fire in check
Less than 15 lbs.,	12	3.6	11	11.72	7	58.4	4	33.3	1	8.3	10	11	12	15.85	4.50
15 to 24 inclusive,	21	6.3	19	4.90	16	76.2	5	23.8	....	....	19	19	....	2.87	11.40
25 to 49 inclusive,	29	8.8	33	3.65	21	72.4	8	27.6	....	....	33	32	....	2.23	7.37
50 and over,	269	81.3	90	2.22	241	89.6	27	10.0	1	.4	91	82	75	1.96	4.55
Total,	331	100.0	78	2.84	285	86.1	44	13.3	2	.6	81	59	43	2.37	5.83

10. EFFICIENCY OF WET OR DRY SPRINKLER SYSTEMS.

Wet or Dry System.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Number and Per Cent. of Fires. Extinguished fire (or practically extinguished)		Held fire in check		Unsatisfactory		Average Pressure. Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Average Number Sprinklers Opened. Extinguished fire (or practically extinguished)	Held fire in check
Wet system,	324	97.9	78	2.66	279	86.1	43	13.3	2	.6	81	59	43	2.24	5.39
Dry system,	7	2.1	84	11.14	6	85.7	1	14.3	....	.....	89	50	....	8.83	25.00
Total,	331	100.0	78	2.84	285	86.1	44	13.3	2	.6	81	59	43	2.37	5.83

11. EFFICIENCY OF WATER SUPPLIES TO SPRINKLER SYSTEMS —As Regards Amount of Loss.

Primary Water Supply.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Number and Per Cent. of Fires.						Average Pressure.			Average Number Sprinklers Opened.		
					No claim		Small loss		Large loss		No claim	Small loss	Large loss	No claim	Small loss	Large loss
Water works,	55	16.6	67	2.49	4	7.3	47	85.4	4	7.3	72	68	39	2.75	1.80	10.25
Gravity tank,	53	16.0	24	5.98	5	9.4	39	73.6	9	17.0	28	25	17	1.80	4.15	17.50
Pressure tank,	216	65.3	94	2.13	22	10.2	174	80.5	20	9.3	100	94	88	1.04	1.87	5.65
Automatic pump,	7	2.1	81	3.85	....	....	5	71.4	2	28.6	....	83	75	.....	3.60	4.50
Total,	331	100.0	78	2.84	31	9.3	265	80.1	35	10.6	85	79	63	1.38	2.22	8.91

12. EFFICIENCY OF WATER PRESSURES ON SPRINKLER SYSTEMS —As Regards Amount of Loss.

Pressure on Sprinklers.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Number and Per Cent. of Fires.						Average Pressure.			Average Number Sprinklers Opened.		
					No claim		Small loss		Large loss		No claim	Small loss	Large loss	No claim	Small loss	Large loss
Less than 15 lbs.,	12	3.6	11	11.72	....	....	10	83.4	2	16.6	....	11	11	.....	7.60	53.00
15 to 24 inclusive,	21	6.3	19	4.90	1	4.8	13	61.9	7	33.3	21	19	19	2.00	2.38	10.00
25 to 49 inclusive,	29	8.8	33	3.65	4	13.8	21	72.4	4	13.8	29	33	33	1.75	2.95	9.25
50 and over,	269	81.3	90	2.22	26	9.7	221	82.1	22	8.2	96	90	88	1.30	1.90	6.50
Total,	331	100.0	78	2.84	31	9.3	265	80.1	35	10.6	85	79	63	1.38	2.22	8.91

13. EFFICIENCY OF WET OR DRY SPRINKLER SYSTEMS —As Regards Amount of Loss.

Wet or Dry System.	Number of fires	Per cent. of fires	Average pressure	Average number sprinklers opened	Number and Per Cent. of Fires.						Average Pressure.			Average Number Sprinklers Opened.		
					No claim		Small loss		Large loss		No claim	Small loss	Large loss	No claim	Small loss	Large loss
Wet system,	324	97.9	78	2.66	30	9.3	261	80.5	33	10.2	83	79	63	1.40	2.16	7.87
Dry system,	7	2.1	84	11.14	1	14.3	4	57.1	2	28.6	135	79	67	1.00	6.50	25.50
Total,	331	100.0	78	2.84	31	9.3	265	80.1	35	10.6	85	79	63	1.38	2.22	8.91

Note—"Average number of sprinklers opened" does not in any case include the Unsatisfactory fires.

View of St. Louis and St. Charles Bridge from South West, about an hour and a half after the fire started, and before South wooden hand-rail collapsed. Direction of wind almost at right angles to length of bridge, yet note flames spreading rapidly across the four through spans.

General Fire Record.

St. Louis Bridge Fire.

St. Louis and St. Charles Bridge Company Bridge, St. Charles, Mo., September 26, 1916.

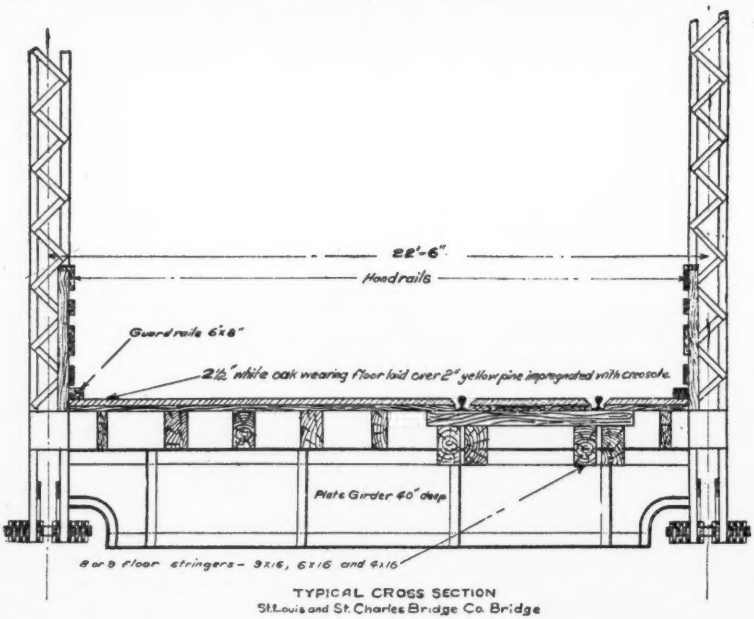
Special Report by Missouri Inspection Bureau (Member N. F. P. A.)

Conditions before the Fire. This bridge spans the Missouri River at St. Charles, Missouri, and forms the main outlet for street car and wagon traffic to St. Louis County and St. Louis City. It was built in 1903 at an approximate cost of $500,000, not including approaches. It is owned by the St. Louis and St. Charles Bridge Company, a corporation with offices in St. Louis.

The total length of the bridge is 2612 feet, divided into three 416 foot through steel spans, one 300 foot through steel span, one 164 foot steel span, inverted truss, one 565 foot timber trestle (west approach), one 336 foot timber trestle (east approach). All spans are supported on cylindrical steel piers filled with concrete, except one concrete pier at the east end of the inverted truss. The spans consist of two trusses twenty-two feet six inches on centers with latticed and boxed steel members. Floor girders were built up forty inches. Plates about thirty feet on centers.

Wooden flooring, consisting of two and one-half inch white oak wearing planking over two-inch yellow pine plank impregnated with creosote and supported by eight or nine wooden four-inch by sixteen-inch and nine-inch by sixteen-inch stringers running longitudinally was laid new in 1914. These stringers or sills rested directly on steel floor girders. There were railroad ties six-inch by eight-inch two feet on centers under street car rails, and wooden hand rails above on each side. (See diagram Page 206).

Fire Protection. The bridge was dependant for protection against fire upon the fire department and water supply of St. Charles at the west end of the bridge. The public water supply was sufficient to maintain forty to fifty pounds pressure at hydrant with flow of 1,000 gallons per minute. A private fire pump of 1,000 gallons capacity, belonging to the American Car and Foundry Company, with hydrants accessible to west approach, was also available. The public fire department consisted of a chief, three full paid men and twelve volunteers, two hose wagons and 3,000 feet of hose. The private fire brigade of the American Car and Foundry Company was also available with thirty-six members and 3,300


22'-6"
Head rails
Guard rails 6"x8"
2½" white oak wearing floor laid over 2" yellow pine impregnated with creosote
Plate Girder 40" deep
8 or 9 floor stringers - 9x16, 6x16 and 4x16

TYPICAL CROSS SECTION
St. Louis and St. Charles Bridge Co. Bridge

feet of hose. There was a telegraph fire alarm system but no private protection of any kind on the bridge.

Details of Fire. The fire started about the middle of the west through span. The cause is unknown. The flooring was worn and splintered in many places; new lumber was piled on the bridge to replace what had been worn out. It is probable that a match, cigar or cigarette was thrown from an electric car which passed over the bridge at about 5 p. m. or by some teamster or foot passenger; and that this lodged in a worn spot and smouldered through to the lower floor layer of soft creosoted wood. The chief states that the St. Charles fire department has been called upon to extinguish several such fires on the bridge. The fire had gained considerable headway before the department arrived in quick response to a telephone alarm at 5.15 p. m. The wind was blowing strongly from the south at right angles to the length of the bridge with an estimated velocity of twenty to thirty miles an hour. Four lines of hose were laid by the city department,—the first one from a hydrant directly under the bridge, and the others from hydrants at the end of the approach, and these were run out on top of the bridge. The American Car and Foundry Company brigade also laid four lines of hose from private hydrants. The fire swept both east and west, being under control at the west end at 9 p. m. and entirely extinguished at 11 p. m. Apparently no damage was done west of the west span, nor to the west approach. Toward the

east, eye witnesses state that the fire traveled at the rate of about thirty minutes per 400 foot span, entirely stripping the bridge of combustible material and destroying the eastern approach. The St. Louis city fire department responded to a telephone call for help with an automobile pumping engine, but no hydrants were available on the east side of the river and they could not place the engine near enough to the low water of the river to take suction. No trusses collapsed, but evidently serious damage was done to the north truss of each span and to floor girders, as was evidenced by many warped and some buckled members. The high wind across the bridge, by blowing the heat away, evidently prevented its complete collapse.

West Approach—not damaged.

West Through Span, looking East. Note warped upright members on left (or North) truss.

Conclusions. Steel members in bridges with wooden flooring are subject to heavy damage from heat. Wooden plank flooring even with an upper layer of white oak becomes worn and splintered by traffic and offers a good place for fire to start from a match or cigar, or possibly from an electric arc between a car wheel and car rail, if the bridge be used by

West through span, looking East, showing flooring and hand rails.

West end of bridge, from South, showing exposures to and from West approach, and contrast between bridge burned clean of combustible material and as it was before.

Twisted rails—all that is left of East approach.

End of inverted truss and first East through span, looking South West. Note buckled and warped floor girder.

electric cars. In this connection, attention is drawn to a bridge fire at Kansas City, Missouri, supposedly started by an electric arc, which did considerable damage to a wooden approach; also to a recent fire on a steel bridge at Detroit, Michigan, carried by live coals dropped on the wooden flooring from a tar wagon, with the result that two spans fell into the river.

The lower floor layer of yellow pine impregnated with creosote probably made the spread of the fire more rapid and increased the temperature.

Recommendations. Steel bridge flooring should contain as small an amount of combustible material as possible. Full equipment of fire barrels and pails should be provided throughout the bridge length. Approaches should be of steel construction. Hose streams should be available from each end of the bridge.

Fire in a Gun Cotton Plant.

S-19644. This was a fire of peculiar interest in several respects. Although the plant was in operation, the precise cause of the fire could not be ascertained, but various theories have been suggested, among them (1) ignition of a centrifugal of nitrated cotton, (2) secret indulgence in smoking by an employee, (3) the presence in the cotton of bleaching material that should have been thoroughly washed out prior to the drying process. In this connection reference may be made to the introductory paragraphs and Part I of Mr. J. Albert Robinson's report on Nitration Products of Cotton and Benzol, published in the QUARTERLY for January, 1916, where the conditions and hazards of this kind of manufacture are described at length.

The fire was discovered at about 3.10 p. m. in a small cotton bin on the top story of the nitrating building at its western end. Windows and doors were open, and unfortunately the wind was blowing from the northwest. Aided by the wind, the flames spread rapidly through the entire length of the building, which was of heavy, hard pine (open mill construction), but which had its wooden walls clad with asbestos shingles. These shingles were of considerable value in holding the fire inside the building. The accompanying photograph illustrates the manner in which many of the shingles held intact by their fastenings to each other and to

Burned nitrating building, showing asbestos shingles holding together after the fire.

building woodwork, after the fire had played havoc with the framework of the building. The other buildings of the plant were not damaged at all by the burning of the nitrating building — a remarkable circumstance which may be explained partly by the fact that the other buildings also were protected with asbestos shingles or sheet iron, and partly by a terrific rainstorm which was in progress during the fire. It is stated that the building was not struck by lightning.

When the fire started, everybody turned fireman, and hose streams were taken from all the yard hydrants. The static pressure from the town water system was about 125 pounds, but streams were put on one by one until there were ten streams from hydrants, and the pressure dropped very considerably, possibly to about twenty-five pounds. The town fire department did all that could be expected, and a neighboring paper mill furnished valuable assistance in the form of a stream, under a pressure of about 190 pounds, from its 1500-gallon fire pump, which was located about 1,000 feet away.

Automatic sprinklers played no part in the extinguishment of the fire as none of the sprinklers in the undamaged buildings operated, and those installed in the burned edifice had never been in commission, owing to the effect of the acid fumes, which had eaten the sprinklers and the sprinkler piping within a very short time after installation. The only protection was a small standpipe and hose and chemical extinguishers.

There was no loss of life, but the building was totally destroyed except for some metal junk salvage. The actual damage done by the fire was about $98,000 and to this must be added the very heavy loss (estimated at $475,000) involved under existing conditions in shutting down the plant for several weeks, at least, pending rebuilding and the installation of new machinery.

Destructive Spontaneous Heating of Sheep Skins.

Special Report.

The recent destruction of about 200 dozen sheep skins by spontaneous heating, in a Boston leather store, raised the question as to whether this class of leather possesses a new and greater hazard than formerly, owing to some change in the process of manufacture. The skins had been in the store about eleven days, when the discovery was made that they were heating, and, upon separating the skins, they were found to be smoking or steaming, and to have become brittle and tender. So far as is known, no actual ignition occurred. Members of the Fire Department or Protective Department were present before or while the pile was being separated.

Investigation of this matter shows that the skins were what is known as "Australian Basils," an Australian sheep skin rough tanned, and imported into the United States in this condition. They are light weight skins of good color, though somewhat darker than the ordinary sumac tanned skins. They are supposed to be tanned with Mimosa, a tanning

material of Australia, and which is said to belong to the Acacia family. The skins are soft and flexible, and do not appear oily, although an ether extraction of a sample by the writer gave about twelve per cent of oil as against eight per cent of oil, solid at seventy-five degrees Fahrenheit from another sample of native pickled skins, extract-tanned in the same factory. These Basils are retanned, dyed black with logwood and iron, and finish dyed with Nigrosine, a coal tar dye, as well as oiled or treated with fat liquor, an emulsion of cod oil and soda ash. These skins are being used to a greater extent than before the war, owing to the comparative scarcity of the pickled skins.

Although the treatment after tanning is not different from that of other skins, the general opinion among leather men, based upon experience, is that while any tanned and dyed sheep skins, if piled while damp, are liable to spontaneous heating and destruction, these Basils offer a distinctly greater hazard, and frequent instances are reported in which such action has occurred, but always after the dyeing.

So far as the writer has been able to discover, no change of importance in the processes has been made. It is probable, therefore, that the result is due to chemical action between the iron and logwood of the dye and the oil and tanning material used in the first or rough tanning, being similar to the well known action in the case of loaded silks due to iron and some form of vegetable tannin.

The possibilities are somewhat complex. We have present fibrous material and animal oil to start with, to which are added fish oil and an iron dyestuff. In a wet or dry condition, any reaction taking place would probably be harmless. In a slightly moist condition, however, a condition which would allow air to penetrate the skins, and piled in such a manner as to prevent radiation of heat generated, an accumulative temperature would be developed, its maximum depending upon the specific conditions present.

In addition, there is a possibility of bacterial action, so common and often essential in tanning operations, aiding the reactions.

In the particular case under consideration, the skins had been recently finished before shipment, and the packages were opened and the skins piled soon after having been received by the dealers. It is probable that dampness was the cause of the heating, the skins not being thoroughly dry at the time.

Of the cases reported, no fire occurred, the action being confined to the destruction of the skins without ignition of other material. How high a temperature was attained is unknown, and it is not known whether fire actually occurred in the skins, or whether the action resulted from a temperature sufficiently high to destroy the value of the skins, but not high enough to cause ignition.

It is probably safe to assume, however, that had readily inflammable material such as paper, etc., been in contact with the mass, ignition might have followed.

Unsatisfactory or Serious Fires in Buildings Equipped with Sprinklers.

Where sprinklers fail, the causes are almost invariably clear. These fires are selected to indicate such causes, that they may be generally understood and satisfactorily met.

S-19448. Storehouse of Flax Spinning Plant. This was a brick building of mill construction, consisting of six stories and a basement. The quantity of stock in storage was very large. The fire started on the fourth story near the center of the room, in which hemp was piled two bales high, separated by alleys. This stock had been in storage for two or three months, and no one is known to have entered the room during the day except a foreman who went in to open a window. At 2.30 p. m. employees in the third story noticed water coming through from the floor above. The master mechanic on receiving the intelligence that a sprinkler had opened, promptly shut off the water at the indicator post gate in the yard. Seeing smoke on his return to the elevator tower, however, he immediately ran back to the post and opened the valve. At about the same time a man working on the fifth floor smelled smoke, and an alarm was sent in to the public fire department. The mill fire brigade laid one line of hose and started the fire pump. The smoke given off by the burning hemp was so dense that no one could enter the room, and the fire was fought from the stair tower. Five of the city firemen were overcome by the smoke and had to be taken to the hospital. The building itself suffered practically no damage, but as the floors were not waterproofed, there was heavy damage (estimated at $150,000) to stock. There was only a small amount of stock on the first floor, and this was removed during the fire.

It was found that forty-seven sprinklers had opened and that these had confined the fire to a space of about thirty feet square in the center of the room. Undoubtedly when water was first discovered coming through the floor, a few sprinklers had opened and were operating to check the fire. When the water was momentarily shut off, the fire gained headway, and the heat given off opened the large number of sprinklers, which, in addition to the hose streams that were used, discharged a very large quantity of water into the burning story.

Summary: Water temporarily shut off.

S-19460. Paper Mill. As the result of a spark from the boilers igniting a pile of shavings on the floor, fire broke out in the sulphite boiler house. The boilers had been shut down for several hours and no employee had been at work in the room since. When seen by an employee the fire was blazing up in the shavings and had ignited the roof. The shavings are delivered from the barkers in the wood room through a large enclosed conveyor to the boiler house. The fire burned back through the conveyor,

destroying it in the wood room building, and also damaging the floor over it. There were no sprinklers in the conveyor, and the pipes supplying the sprinklers in the boiler house were found to be clogged with chips and small stones which had been pumped into the system, with the result that no considerable quantity of water was available for the extinguishment of the fire though there were indications on the ceiling that some water was delivered by some of the sprinklers at the northeast end of the boiler house. In all, 122 heads opened, 48 in the boiler house and 74 in the wood room building, where also it would seem that several heads failed to operate properly. Ten large hose streams were used by the public firemen, who cut holes in the roof. The roof covering of the boiler house was practically destroyed, together with the conveyor, and some damage was done to the floor, windows and fittings of the wood room building.

Summary: Sprinkler pipes clogged.

S-19482. Furniture Factory. This building was an ordinary three-story joisted structure, 225 feet by 70 feet, without basement. The front, rear and west walls were of brick-veneered construction, and the east wall of brick twelve inches thick on all floors. The roof was tar and gravel. The elevator at the rear was enclosed in a wooden shaft. The main building and a small iron-clad engine room adjoining it were sprinklered, but at the eastern side was an unsprinklered triangular one-story brick addition. On its western side, the main building was connected at the second floor level by an enclosed wooden bridge, sixty feet in length, and also equipped with sprinklers, to a second building. No fire doors were provided at either end of the bridge. When the first alarm was turned in, fire was bursting from the rear windows of the main building. Thick smoke issued from the windows all along the building and completely filled the driveway between it and the second building. It being apparent that the sprinkler system was not checking the fire, special calls for more apparatus were sent in. By this time, the fire had ascended the wooden elevator shaft to the top floor and, although it was impossible to see inside the building through the dense smoke, the fire department officials were certain that the sprinklers were not operating in the section which was on fire. The flames were rapidly spreading to the front of the building, and the fire pump located in the main engine room in the second building was not started, as the fireman, fearing that the entire plant was to be destroyed, pulled the fires from the boilers, leaving the pumps without source of power. Had the pumps been available for use, they could have been turned to advantage by the firemen, and they were in fact used later on (after the fires had been re-built) when streams were needed to extinguish a second outbreak in a warehouse to the north. Within thirty minutes of the first alarm, the rear of the main building was a mass of flames and the brick-veneered walls were beginning to fall. A section of the east wall fell upon the roof of the one-story brick addition, causing it to collapse and setting it on fire, and involving a fractured limb for a

fireman who was compelled to jump from the roof. When the fire had gained the vicinity of the second building, it had become very fierce, and the blast of heated air which rushed through the enclosed bridge opened all the sprinkler heads in the bridge and one in the building beyond. The heads in the bridge were supplied from the second building, and checked the fire, which did not damage the bridge for more than about ten feet. Fortunately the shingle roof of the bridge had been well soaked by a rain which had fallen for several hours. The front and rear sections of the burned plant were supplied by independent risers in the sprinkler system, and it was noticed that the heads in the front section were operating, although the pressure was so low that the water did not spray, but merely flowed downward in a comparatively small stream. In spite of the operation of these heads, therefore, the fire spread to the extreme front of the building on the top and second floors. The sprinklers were however, of some assistance, for after the rear section had burned almost completely, the fire was extinguished in the front section with comparative ease, leaving the walls standing and the floors in place, practically from the point covered by that part of the system which was supplied by the front riser.

During the fire in the main building constant attention had been given to the iron-clad warehouse to the north, streams being turned on it at intervals and frequent inspections made of its interior. At the end of about three hours, the lines of hose crossing the railroad track nearby having been "cut" to allow the passage of three trains, a fire captain and fireman thoroughly inspected the warehouse and found everything in good order without a sign of fire. They closed the doors and proceeded to inspect an adjoining lumber yard, returning in about eight minutes to find the warehouse a mass of flames inside from end to end. Two lines of hose were then attached to the fire pump in the main engine room and excellent streams obtained. The warehouse was, however, completely destroyed, and it was with difficulty that a dry kiln at its further end was saved from destruction, the fire communicating to its interior despite a parapetted brick wall between it and the warehouse.

There seems to be no question that, as a result of the closing of the valve, the sprinkler riser in the section in which the fire originated contained no water. It was admitted that the system had been shut down on the previous day in order to remedy a "tripping" of the valve, but the engineer stated positively that the valve was opened before the plant was closed for the night. Either this was a mistake, or the valve had been again closed before the fire started. While the ruins were still burning, the night watchman was detected attempting to open the valve, and the following facts subsequently came to light: — the "shut" indicator was badly burned; the screw was bright in the portion which would be protected with the valve closed, and burned in the section which would be protected with the valve open; a cleaning plug was found removed, leaving a four-inch opening in the valve which, had the latter been open, would have allowed the water to escape to such an extent that there

would have been little or no pressure in the system; the valve had not tripped; a large number of sprinkler heads were burned completely off, and others were found which had not opened on account of corrosion from whitewash.

Summary: Water shut off.

S-19515. Munition Factory. When discovered, this blaze was comparatively small, and the workmen who discovered it in the machine shop attempted to extinguish it by the use of fire pails but were unsuccessful, the fire spreading rapidly and involving the major part of a three-story building before the town fire department arrived on the scene. The high pressure and large volume of water available enabled the firemen to stop the fire and save the south end of the building, but the loss was heavy. The shop was equipped with a modern system of sprinklers, but at the time of the fire the system was disconnected while structural changes were being made.

The loss from this fire would probably have been smaller had an alarm been sent in as soon as the outbreak was discovered.

Summary: Water shut off.

Points of Interest from Fire Reports.

These notes are intended to illustrate the efficiency or inefficiency of signaling, retardant or extinguishing agencies.

Extinguishers.

S-19600. Printing Works. During a severe thunderstorm a lightning bolt struck the south side of the open courtyard in the center of the building and traveled along the iron lighting conduits until it reached a large main junction box in the basement, where it set fire to the insulation and melted a large hole in the corner of the box itself, through which fire and smoke issued. Employees in the room seized chemical extinguishers and played on the fire, but until the current was shut off a few minutes later, this only served to increase the trouble. When the current was shut off the employees easily extinguished the fire. So quick was the response of the employees that a sprinkler head within one foot of the box did not operate, though an examination of it showed it to be in excellent condition. The fire did not get beyond the box and the only loss was the cost of electrical repair work.

Automatic Sprinklers.

S-19468. Rolling Mill. Fire broke out in a pile of clean burlap bags at the base of a wall of frame construction. It gained great headway at once, being helped by considerable deposits of fine coal dust. Thirty sprinklers opened and all apparently had abundant water, but the distribution was seriously obstructed by many cross timbers, conveyors,

belts and runways. The flame was so intense that it passed the first two lines of sprinklers, but it was held by the third line, the ceilings over these being but little charred. About twenty feet of the south end of the main building and a small shed adjoining were badly damaged, including contents. Both fire pumps were started promptly and maintained good pressure during the fire. The sprinklers soon had the fire under control.

S-19532. Printing Works. A four-foot unsprinklered basement to a small frame addition on the west side of the main building was used for the storage of old rope. This basement was shut off by boards and had a board door, and when fire broke out in it from an unknown cause, the flames burned up through the floor and inside the wood sheathing of the walls, reaching the first and second floors of the main building, the nearest sprinklers in which, as well as those in the frame addition, opened and prevented much fire damage. A considerable amount of water damage was done, however, and the total loss was estimated at about $7,500.

Had the sprinkler system been extended to cover the small basement in which the outbreak occurred, the loss would have been negligible.

S-19594. Clothing Factory. Fire occurred in an embroidery stock room which is enclosed by a frame partition reaching to the ceiling on one side and to within two inches of the ceiling on the other three sides. The room is about eight feet wide and has a tier of shelves about two feet deep on either side. These shelves were well stocked, and the three sprinklers in the room could only get the water to the outer face of this stock, obliging the fire department to use a stream. The large loss (estimated to exceed $20,000) was mainly due to the obstruction offered by the shelves to the distribution of the water, and to the circumstance that a stock of large value and of exceptional susceptibility to damage by water was stored in a small area.

S-19601. Car Shops. Iron exhaust pipes extending through the roof of the engine room were struck by lightning and ignition of the roof followed. The fire spread through a concealed space between the wood ceiling and the roof joists. This space was entirely enclosed and was not protected with sprinklers. The fire did not burn through the ceiling and consequently no sprinklers opened, but there was considerable fire damage to the roof and water damage to electrical apparatus in the engine room.

Thermostats.

H-11773. Laundry. In this case the automatic alarm failed to operate owing to poor ground connection. The system was grounded by clamp to a steam pipe, and corrosion had set in to such an extent that current could not pass through. This condition arose very shortly before the outbreak of the fire. The transmitter did not operate and the first notification received by the supervisory service was when their main circuit was grounded by the water from the fire department.

Fire Doors.

H-11770. Foundry. This fire occurred in a brick foundry located at the rear of a five-story brick building, and is supposed to have been caused by a spark from the cupola. Flames were observed coming through the roof of the foundry by the watchman from the windows on the third floor of the five-story building. The roof of the foundry was badly burned and the second and third story windows overlooking the roof were charred, but no fire entered this portion of the premises. The fire doors between the boiler house and the foundry were shut and prevented fire from entering the boiler house. These fire doors were directly against a room used for the storage of wooden patterns for machinery, etc., which were entirely consumed, and as the wind was driving the flames against the doors, these were subjected to great heat. The two-inch tin covering of the door on the foundry side of the wall was badly curled and the wood core was charred, but the door on the further side was not harmed. Having regard to the direction of the wind, it is probable that but for the fire doors, and the prompt arrival of the public fire department the loss would have been very much greater.

H-11783. Packing House and Slaughter. In this plant the smoke houses are inside the main building but are well cut off in batteries of four by brick walls and automatic fire doors; they are continuous from basement to roof with iron gratings at each floor level, the wood fire being built on the floor in the basement and smoke rising up through the house to a metal flue at the roof. The particular smoke house in which the fire occurred contained little meat, but the gratings were probably covered with fat, for the fire flashed up through the house very rapidly. The fire doors, however, proved effective in confining the fire to the house of origin, and the use of approved chemical extinguishers was of great assistance in subduing it. The principal loss was on account of damage to the metal work of the gratings and meat carriers.

Pumps.

H-11737. Roofing Paper Plant. The three buildings destroyed were frame metal clad structures located a few feet from each other, with mutually exposing windows. Asphalt from a tank car on tracks between two of the buildings was being forced into the buildings by compressed air, when in some unaccountable way the car took fire. An alarm was instantly sounded; the fire pump was started; and the private brigade began to fight the fire. Within a short time from the commencement of the fire all three buildings were afire in all parts. Outside help had been summoned and the water supply from two electric service pumps of 250 and 1,500 gallon capacity was turned into the yard mains and additional streams played on the fire. The four-inch steam line from the main boiler house to the fire pump ran overhead close to the buildings and was put out of commission when the buildings began to collapse. This left the fire pump practically without any steam for some time, as steam had not

been maintained in the boilers located near the pump house for use of the fire pump alone. After the collapse of the steam line, half an hour was lost in raising steam in the special boilers. The loss on the buildings and contents was total.

S-11755. Chemical Works. This fire was subdued by outside assistance, but the electrically driven pumps provided for the protection of the plant were rendered useless for the purpose of fighting the fire by the burning of the wires supplying the necessary current.

These two fires illustrate the importance of so installing fire pumps and their accessories that their operation will not be readily affected by the outbreak of the fire which they are intended to fight.

Miscellaneous.

S-19387. Cotton Mill. A hot bearing caused fire on a napping machine. The fire immediately flashed up over the machine, igniting the cloth and spreading to two adjoining machines. Twelve sprinklers opened and small hose streams and extinguishers were used, apparently extinguishing the fire in about thirty minutes. After the sprinklers were shut off, fire was found smouldering in the cloth on one of the trucks. This necessitated the turning of the water on to the sprinkler system, as there was no separate supply for the small hose.

S-19455. Forge Shop. This fire was caused by a small overflow from an oil tank in which dies were tempered. The oil was ignited by the heat of a furnace near which the tank is placed for the purpose of keeping the oil fairly liquid. Usually such occurrences are taken care of by smothering with damp bagging or by the use of sand. On this occasion one of the men soused the oil with a pail of water, and part of the water getting into the tank made more oil overflow. A flame resulted which reached to the roof and ignited the dust between the boards. The greater part of the damage was due to the ripping off of the slate to make sure that there was no fire between the boards and under the slate. Five sprinklers opened and practically extinguished the fire.

S-19572. Carpet Yarn Mill. In this case the use of hose streams supplied from the sprinkler system on an upper floor averted an exposure fire from an adjoining property which was badly gutted. By wetting down the roof of the menaced section of their plant the superintendent and his men succeeded in keeping it free from any fire or water damage, although they were unable to prevent considerable loss from smoke which poured into the building through cracks in a brick wall and around window frames, etc. But for this commendable vigilance and promptitude in attacking the fire, a much heavier loss would undoubtedly have been incurred.

Fire Causes.

The fires here given are selected to illustrate defects, either of construction or superintendence in the classes of property indicated.

Gasoline and Other Volatiles.

H-11683. Bonded Whiskey and Alcohol Warehouse. This fire was caused by the sparking of the rotary starter of the elevator motor. The motor has two sets of points, one for forward or up, the other for reverse speed. One of the points was slightly bent, making a poor contact. The starter was located on the second floor and provided with a sheet iron hood, but this was not vaporproof. On the third floor alongside the open elevator shaft, a galvanized steel tank of 1,059 gallons capacity had been filled with alcohol from the cistern room in an adjoining building. A down draft had carried fumes to the second floor, and when sparking occurred in the starter these fumes ignited. The purpose of the tank was to fill barrels on an outside shipping platform at a railroad siding, and it was piped down to this platform. As soon as the fire started, an employee opened the tank and drained it to the outside platform. The fire was at first a flash fire up the side of a sheathed wall, but on reaching the top floor it attacked the wooden racks upon which whiskey barrels were stored in tiers. The fire was extinguished with chemicals and hose streams, and it was estimated that had the fire continued fifteen minutes longer it would have released the whiskey, and the building would have been totally destroyed. The prompt draining of the alcohol tank was an important factor in saving the building, the damage to which was practically confined to the top floor and the roof.

H-11744. Window Shade Factory. An employee was cleaning a bristle paint brush in a metal pail of naphtha. He was giving the brush a vertical motion in and out of the naphtha when the latter flashed and caught fire, owing, it is supposed, to the presence of static electricity. The employee was badly burned and as there were several barrels of naphtha and other inflammable contents in the building, this became a total loss after a very quick and hot fire.

In this fire we have an illustration of the danger of keeping barrels of naphtha inside buildings. Naphtha should be stored underground in tanks of approved construction.

Electrical.

H-11701. Foundry. The blower for the heating system was located on a platform near the roof and was being repaired at the time of the fire. An electrician's helper was holding an electric light on an extension cord to furnish light for the repair operations. He accidentally dropped the light, the bulb was shattered, and the socket struck an iron plate in such

a way that sparks were produced and some oily waste thereby ignited. The fire quickly reached the roof and did damage to the extent of about $7,500 before it could be extinguished.

This fire emphasizes the need of constant care in handling electric lights, especially temporary or extension attachments. All extension lights should be equipped with wire guards whenever used.

S-19598. Clothing Factory. This fire occurred at 7 a. m. on a Monday morning among some rolls of cloth stored on a wooden shelf. An electric light cord was found burned off, but a piece remaining showed where it had rested on the piles of goods. It was probably left in this position on the previous Saturday night. All the current is shut off the different floors every night, and the theory is that the particular piece of cord was defective, and that when the current was turned on in the morning, a short circuit occurred and started the blaze.

Blower Systems.

H-11735. Cutlery Factory. A small power saw used in cutting composition celluloid knife handles was the cause of this fire. The handles were made elsewhere and were bought in a rough state to be sawed and buffed at the factory. A spark was struck from the saw, igniting dust around the saw and on the floor near, and fire was thence communicated to a box of handles. The saw was connected to a blower system discharging safely out of doors, but this did not take care of all the dust. Containers of handles should have been kept further away from the saw, but it is to be noted that **if the blower system, which was stopped as soon as the fire started, had been allowed to remain in operation it would have drawn the fire out of the room into the metal duct conveyors where it could probably have been easily smothered with chemical streams.**

S-19556. Patent Leather Tannery. The cause of this fire is unknown but it originated in a wooden dust box in the yard, to which the dust from the buffing room is blown, first through a metal pipe, and then through a wood chute which discharges into the box. The fire spread from the box to the wooden chute. Aided by a strong wind, it attacked the side of, and got a short distance into, the building. The loss was heavy. An examination of the blower pipes directly behind the buffing machines indicated that the fan was not properly clearing the pipes but was allowing large accumulations of dust in which a spark might smoulder.

It is desirable that buffing machines should be connected by metal pipes direct to a metal arrester or concrete box in the open air, and that the blower should be of ample size to keep the pipes clear.

Chimneys and Flues.

H-11708. Summer Hotel. The entire premises were destroyed by a fire which is thought to have originated in a faulty chimney. The season was over and the house was shortly to be closed. One of the fireplaces had been used for burning up old rubbish, and this probably set fire to the chimney, which communicated the flames to the woodwork.

H-11726. Pottery. Workmen discovered this fire coming through the floor of a drying room located directly over the boiler. Investigation after the fire showed that the brickwork enclosing the metal flue had fallen in, the flue being badly corroded and unreliable. It is believed that the brick setting fell through the flue before the fire occurred, and that sparks escaping through the hole thus formed caused the outbreak. The floor of the drying room being only a few inches above the boiler setting, the heat there was abnormal and without doubt aggravated the fire.

In addition to the need for attention to the condition of flues, this fire emphasizes the desirability of using fire resistive, or at least noncombustible, material for the construction of floors exposed to exceptional heat.

S-19410. Machine Shop. On the fifth floor of the building in which the fire occurred is located a dip room where armature coils are dipped in a mixture of varnish and benzine. Extending from this room through a room above to the roof is a sheet iron flue thirty inches square, and on the roof is a fan house of frame construction about three and a half feet square. Almost immediately after the fan had been set in motion, it was noticed that the top of the flue was on fire. The fire undoubtedly originated from a spark thrown off from the brushes of the fan motor, which ignited a collection of oily dust and other deposit about the machine and fan. This apparatus was not well arranged for inspection and care, and there was in all probability quite an amount of combustible deposit on the inside of the flue as well. The heat radiated through the sheet iron and set fire to patterns on the top floor, where three sprinklers opened and practically extinguished the blaze. The flue and fan house were practically destroyed, and there was slight water damage.

S-19595. Cutlery Works. Oily soot collected in a metal flue from the hood over a hot oil tempering bath. The flue was connected also with vents from oil-fired annealing furnaces and, by a short horizontal run of brick flue, with the boiler stack at a point below the boiler flue breach. The soot became ignited from some cause, and fire escaped through cracks in the brick flue, charring ceiling woodwork and causing a sprinkler to operate. The sprinkler extinguished the fire outside the flue, but the metal ceiling over the flue was removed to make sure that the fire was extinguished.

Miscellaneous.

H-11679. Forge and Smithy. An employee was filling a hopper near the puddling furnace with pulverized coal, and in some manner the coal sifted down in front of the furnace where the fire ignited the fine coal dust. This fine dust ignited the dust on top of the furnace and in turn communicated with the dust in the truss work. It was said that only a moment after the fire was first seen, the entire roof, which was built of timber truss and plank, was on fire. The fire continued to burn until the roof fell in, taking with it all the steam lines, coal conveyors, etc.

This fire emphasizes the disadvantages of the readily combustible

roof and also teaches the necessity for care in the handling of such fuel as pulverized coal.

H-11732. Paper Mill. A kerosene oil stove used for heating glue pots was responsible for this fire. The stove is stated to have exploded and to have set fire to a pile of waste paper. **The employees began fighting the fire but they omitted to turn on the valve controlling the dry sprinkler system and to notify the fire department until the expiration of half an hour.** The loss was estimated to exceed $35,000.

H-11734. Cutlery Works. Directly after closing time, when the men were about to leave the plant, an employee discovered a fire on the woodwork in close proximity to one of the oil-fed forges. The blaze was quickly extinguished with water pails and hand extinguishers. The cause of the fire is not absolutely certain but it is thought that a few moments after the plant had shut down, the power was restarted for the purpose of replacing a belt, thus starting the oil pump to the forges. The power given to the pump by these few turns of the wheel was not sufficient to drive the oil clear to the interior of the forge, but enough oil was forced out of the feed pipe to drop on the hot walls of the forge. This ignited and fell from the forge to a block of wood directly underneath. **On this theory it is clear that the valve on the feed pipe to the forge could not have been closed before leaving. This precaution should always be taken to prevent the occurrence of such accidents as that now recorded.**

S-19563. Metal Worker. An ordinary kerosene lantern was used for heating the dry valve closet in connection with the sprinkler system. A city gas main extending underground through the yard apparently became broken or was leaking badly. The gas leaked into the pattern storehouse and it was claimed that the flame from the lantern ignited the gas and caused the fire. Four sprinklers opened and practically extinguished the fire.

S-19436. Metal Worker. This fire originated in a violent explosion in a japan baking oven. The ovens were heated by fuel oil burned in a flue under the floor and provided with iron plate covering. The practice was to keep a damper in the ventilating flue of the oven open when work was first put in, and to close the damper gradually as the baking progressed, never intending to have it fully closed. It seems probable that by mistake a damper was completely closed and that gases given off from the japan accumulated, formed an explosive mixture with air, and ignited.

H-11775. Oil Refinery. Presumably as the result of a small leak, an explosion occurred in the fire box underneath the crude oil still. The furnace was wrecked and the fire blown in all directions. The pump house (oil pumps) of iron-clad construction was in close proximity to the still and between them was an open oil catch basin. The oil in the basin took fire and the flames immediately attacked the pump house, spreading thence to several steel tanks nearby. The loss was heavy.

This fire well illustrates the dangers of a too congested plant.

H-11803. Foundry. This fire started on the roof of a frame building used for pattern storage and making. The roof (partly shingle, partly roofing paper) was ignited by sparks from a refuse burner 200 feet distant. Fires on the roof from this cause had been frequent, as the mesh of the spark arrester at the refuse burning plant was unfortunately not fine enough to arrest the sparks; but previous outbreaks had been extinguished by employees with hose. The buildings and stock valued at more than $150,000 were a total loss.